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BARLEY:
GROWING THE CROP.

BY

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., February 4, 1911.

SIR: I have the honor to transmit and to recommend for publication as a Farmers' Bulletin the accompanying manuscript, entitled "Barley: Growing the Crop," prepared by Mr. H. B. Derr, Agronomist in Charge of Barley Investigations, under the direction of Mr. M. A. Carleton, Cerealist in Charge of Grain Investigations.

Of the small-grain crops grown in this country barley ranks third in production. While much of the area devoted to this crop in the United States is suited to its production, the lack of care in selecting seed and the methods of cultivation practiced result in low yields of poor quality. This bulletin gives directions for the best methods of growing and harvesting the crop. With the use of these methods there should be a marked increase in the yield and quality of the barley grown in the United States.

In the preparation of this bulletin data have been used from the reports of superintendents of experimental farms of the Department of Agriculture, from the reports of cooperators, and from the publications of various agricultural experiment stations.

Respectfully,

WM. A. TAYLOR,
Acting Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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BARLEY: GROWING THE CROP.[a]

INTRODUCTION.

While much of the early history of barley is uncertain it is generally admitted that it was one of the first cereals to be cultivated. Its cultivation in the United States dates back to the time of the earliest colonists, but the introduction of improved varieties[b] did not begin until the middle of the nineteenth century. The production of barley has rapidly increased in late years, until at present it ranks fourth in value among cereals.

Fully half the crop is used for brewing and malting; but careful feeding trials conducted by the various agricultural experiment stations and by many farmers have demonstrated its worth for feeding, especially to cattle, hogs, and sheep. This knowledge of its feeding value has tended to considerably increase the production, especially in areas where the production of corn is rather uncertain.

The annual yield per acre in the United States for the past ten years, as given by the Bureau of Statistics, is only 25.7 bushels, while that of Germany and Great Britain is more than 8 bushels greater. When we consider that in the States of California, Texas, Kansas, Nebraska, and North Dakota, the average yield of barley for the past ten years has been less than 25 bushels per acre, and in 24 of the States the yield has been considerably less than 30 bushels, there is no doubt that with proper efforts along the lines of seed selection and preparation of the soil, the average yield can be considerably increased and made to compare more favorably with that of Germany and Great Britain.

ORIGIN AND EARLY HISTORY OF BARLEY.

Barley is supposed to be a native of western Asia, where wild forms still exist. Some botanists claim that the original type from which all of our cultivated varieties have been produced is *Hordeum spontaneum*, a wild, two-rowed form found on the barren hillsides of Palestine. Others believe that there was a wild six-rowed form, as all of the ancient inscriptions are of the six-rowed and not of the two-rowed type.

[a] Other publications relating to barley, which may be obtained free upon request to the Secretary of Agriculture, Washington, D. C., are "Barley Culture in the Southern States," Farmers' Bulletin 427, U. S. Dept. of Agriculture, 1910; "Barley Culture in the Northern Great Plains," Circular No. 5, Bureau of Plant Industry, 1908; "The Separation of Seed Barley by the Specific Gravity Method," Circular 62, Bureau of Plant Industry, 1910.

[b] The word "variety" is used in this bulletin in the ordinary commercial sense and does not usually refer to a pure race or pedigreed strain.

Barley was cultivated by the people of western Asia nearly 2,000 years before the Christian era. Pliny makes the statement that barley was among the first cereals cultivated for food. This grain is mentioned by early writers in Egypt, and the high esteem in which it was held is shown by the fact that Egyptian coins estimated to be several thousand years old bear figures of barley heads. Specimens of this grain taken from Egyptian tombs, estimated to be over 3,000 years old, are in the British Museum; representations of barley heads are also found on these tombs.

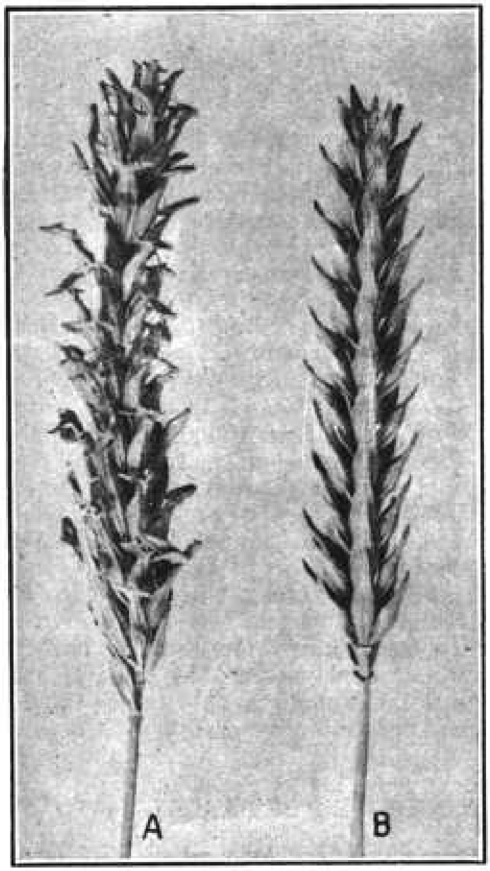

FIG. 1.—The two types of awnless barley: *A*, Hooded; *B*, the new hybrid awnless variety, Arlington Awnless.

As a crop, barley is mentioned in Exodus (ix, 31) and in other books of the Bible, and from all indications the greater portion of the grain in Biblical times was barley. It was evidently among the chief food-producing plants of the Jewish race and of the surrounding nations. From western Asia barley was early introduced into southern Europe and gradually spread northward. Its cultivation in early times is shown by the finding of charred grains in the homes of the prehistoric people of Europe. Ancient historians, including Pliny and Theophrastus, refer to the value of this grain for both food and drink. The armies of Europe in early times largely subsisted on barley. After the introduction of wheat and rye these grains gradually replaced barley for human food, especially in Europe, but it is still so used in portions of western Asia.

BOTANICAL CHARACTERS.

General description.—Barley belongs to the Gramineæ or grass family and to the genus Hordeum. The different groups of cultivated barley have usually been considered as distinct species, but they are now regarded by some botanists as varieties of a single species, *Hordeum sativum.*

The plant is somewhat similar to wheat and rye, although generally not so tall. It tillers quite freely, some varieties producing as high

as 15 culms, depending on the thickness of planting and the fertility of the soil. The leaves, which are of a grayish-green color, are broader than those of other grains.

The head of barley, as of wheat or rye, is a spike in which the spikelets or flower clusters are arranged along a central stem or rachis. This rachis is made up of short joints, curved alternately in opposite directions, giving it a zigzag appearance. The spikelets are arranged in groups of three at the upper end of each joint, each group lying in the inner side of the curve of the joint above. In the six-rowed barley all the spikelets are fertile. In the two-rowed barley, however, only the central spikelet produces grain, the two lateral spikelets being infertile, thus giving the head the two-rowed appearance.

FIG. 2.—The two types of six-rowed barley grown in the United States: *A*, Round six-rowed (*Hordeum hexastichon*); *B*, Square six-rowed (*Hordeum vulgare*).

Each fertile spikelet contains a kernel, which is inclosed in the flowering glume and palea, which together form the hull. In the hull-less varieties these are easily removed in thrashing, as in wheat, while in the common varieties they remain firmly attached to the kernel. In the bearded varieties the median nerve of the flowering glume, which forms the greater portion of the hull, is prolonged into a beard or awn 3 to 6 inches in length. A new form of awnless barley (fig. 1, *B*) has recently been produced by the Office of Grain Investigations. In the hooded, or so-called beardless barleys (fig. 1, *A*), the beard is replaced by a three-pronged appendage, the central portion of which is bent over, giving it a hoodlike appearance.

Surrounding the base of the spikelet, but not attached to it, are small, slender appendages known as the outer glumes. In some varieties the central portion of these extends into a soft, bristle-like awn,

while in others it is blunt or slightly pointed. Both the common and the hull-less varieties of the six-rowed bearded and of the six-rowed hooded types are grown. Of the two-rowed bearded type there are both common and hull-less forms; of the two-rowed hooded only the common form is grown in this country.

FIG. 3.—The Manchurian or square type of six-rowed barley. The heads with the beards removed show the arrangement of the spikelets. Ninety-five per cent of the six-rowed barleys grown in the United States are of this type. Among the most prominent varieties are Manchuria, Oderbrucker, Odessa, and Common California.

Description of the various types.—The arrangement of the spikelets in the head is the distinguishing character between the round six-rowed barley, *Hordeum hexastichon* (fig. 2, *A*), and the square six-rowed (commonly called four-rowed) barley *Hordeum vulgare* (fig. 2, *B*). In the round barley, of which Utah Winter is the best example, the spikelets appear as if radiately arranged upon the rachis, giving the head a round form, while in the square barley (fig. 3), or Manchurian type, the heads assume a square appearance due to a twisting to either side of the lateral spikelets. Owing to this twisting there is an overlapping of the lateral grains with the resulting square, compact form of head. The bearded hull-less and the hooded varieties are included in the *Hordeum vulgare* group.

Two types of two-rowed barley are cultivated in the United States. One has a long, slender head which bends over or nods when ripe (fig. 4, *B;* fig. 5). The Chevalier barley is a good example of this type. Fully 90 per cent of the two-rowed barleys grown in the United States are of this slender form, which is typical of the *Hordeum distichon* group. The other type has short, broad, erect heads,

the awns sometimes spreading (fig. 4, *A*). The Primus variety is a good example of the latter type.

FIG. 4.—The two types of two-rowed barley grown in the United States: *A*, The short form with spreading awns; *B*, the long, slender form which is most typical of *Hordeum distichon*.

Identification of the different groups by means of the grain.—While it is almost impossible to identify the varieties of barley by an examination of the grain alone, the various groups can be readily recognized.

In the bearded barleys the six-rowed type can be identified by the presence of two smaller twisted grains for each large straight one, while in the two-rowed type there are no twisted grains. A mixture of the two-rowed and six-rowed types can be detected by noting the proportion of straight and twisted grains. Figure 6 shows grains of the two groups.

In the hull-less barleys the form and color of the kernels aid in distinguishing them. In the hooded barley, called White Hull-less (fig. 7, *A*), the grains when grown under ideal conditions are large, plump, and of a clear amber color. In the Himalaya (Guy Mayle) barley (fig. 7, *B*), the grain is medium to large and its color is bluish green. Black Hull-less (fig. 7, *C*), which is a bearded variety, can be recognized by the deep-purple color of the grain. The two-rowed bearded hull-less barley (fig. 7, *D*) can be distinguished from the six-rowed by the larger, broader, rather flat grain, usually of a dark amber color with a brown tip.

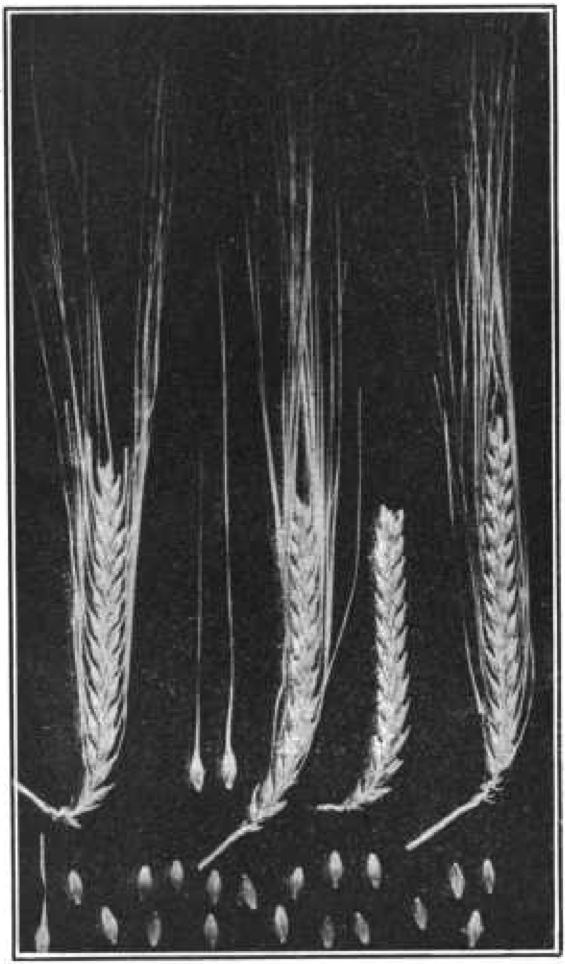

FIG. 5.—Heads and grains of the long, slender type of two-rowed barley. (One head with beards removed.) Fully 90 per cent of the two-rowed barleys grown in the United States are of this type. Among the most prominent varieties are Chevalier, Hannchen, and Hanna.

INTRODUCTION OF BARLEY INTO THE UNITED STATES.

Early introductions.—Barley was introduced and cultivated by the colonists of Massachusetts and Virginia early in the seventeenth century. In the latter part of the same century considerable barley was grown in Rhode Island and by the Dutch in New York. With the movement of colonization westward along the Great Lakes and down the Ohio River, the crop was carried into new areas and soon became extensively cultivated. Its spread has continued to the present time and it is now generally

grown in the upper Mississippi Valley and the Rocky Mountain States.

Previous to the organization of the office of Commissioner of Agriculture, a number of new varieties of barley were introduced and distributed by the Commissioner of Patents, the first of these distributions being recorded about 1845. The popularity of the crop was largely increased by the success of these introductions, which included hooded (beardless) and hull-less varieties which have given excellent results in the higher portions of the West.

FIG. 6.—Grains of six-rowed and two-rowed barleys, showing differences by which they can be identified: *A*, Six-rowed—Nos. 1 and 3, ventral surface; 2 and 4, dorsal surface of kernels. Note the twisted appearance of the outsite (lateral) kernels as compared with the straight median one. A sample of six-rowed barley should have twice as many twisted (lateral) kernels as straight ones. *B*, Two-rowed—both dorsal and ventral surfaces shown. There should be no twisted grains in a sample of two-rowed barley.

Recent introductions.—The Department of Agriculture, through the offices of Seed and Plant Introduction and of Grain Investigations, has in recent years introduced and distributed a large number of varieties of barley. Several pedigreed two-rowed varieties, including Chevalier, Primus, Princess, Hannchen, and Swan Neck from Sweden, have given excellent results. The excellent yields from these pedigreed barleys in the past few years demonstrate their superiority over the common ones. Among the most promising of the six-rowed barleys introduced by the Department are the Odessa and the Gatami, which are giving good results in the Northwest, leading

in yield at several experimental farms. The hooded and hull-less barleys which were introduced from the Himalaya Mountains in Asia, where they are grown at elevations as great as 11,000 feet, and from other sections have matured grain in the United States at 8,000 feet in Idaho and at 9,800 feet in Colorado.

BARLEY-PRODUCING AREAS OF THE UNITED STATES.

Location of the areas.—Barley can be grown in nearly every State, but the greater part of the crop is produced in certain definite areas. The largest area (fig. 8) includes eastern North Dakota and South Dakota, western and southern Minnesota, southern Wisconsin, and northern Iowa. The area next in extent is in California. This crop

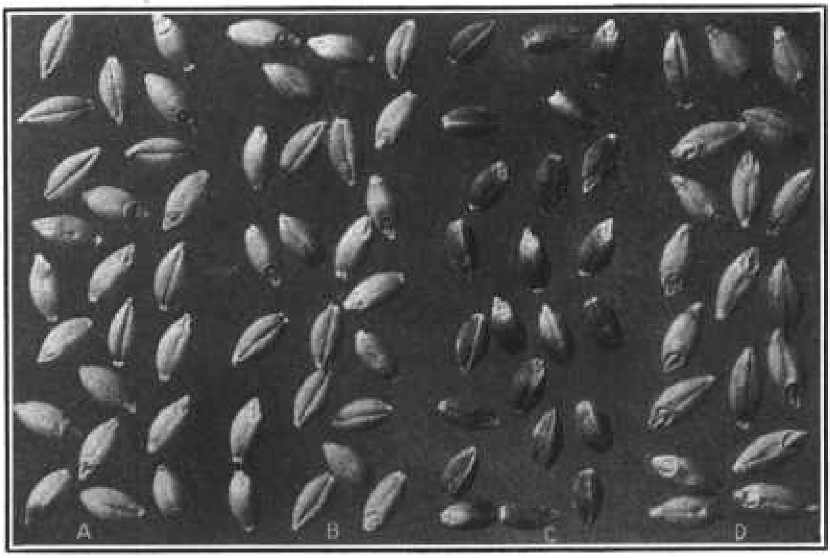

FIG. 7.—Grains of four varieties of hull-less barley: *A*, White Hull-less, six-rowed; color of grain, pale amber. *B*, Himalaya (Guy Mayle), six-rowed; color, bluish green. *C*, Black Hull-less, six-rowed; color, purple. *D*, Two-rowed Hull-less; color, dark amber.

is also grown in eastern Oregon, eastern Washington, and western Idaho. A small isolated area is found in western New York, and another in southeastern Michigan, northwestern Ohio, and northeastern Indiana. Barley is also produced in eastern Nebraska, western Kansas, northeastern Colorado, southeastern Wyoming, and central Montana. The crop is grown in other States, but the areas mentioned include practically all of those sections in which its cultivation is important.

Types of barley adapted to these areas.—Different types of barley are adapted to the various areas, or even to definite portions of a single area. Thus, in the largest barley-growing district, the six-rowed barleys, Manchuria, Oderbrucker, and Odessa, as shown in a previous publication,[a] do best in Minnesota, Wisconsin, Illinois, Iowa, and

[a] Carleton, M. A. Barley Culture in the Northern Great Plains. Circular 5, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1908.

Nebraska, while in North Dakota and South Dakota the two-rowed varieties, such as Hannchen, Swan Neck, Chevalier, and Hanna, give better results. Six-rowed barley is principally grown in western New York and in Michigan, Ohio, and Indiana. In Kansas, Oklahoma, Texas, and the Southern States generally the most profitable variety to grow is the six-rowed Tennessee Winter. In the high altitudes of the Rocky Mountain States hooded barley is the most profitable type. In Utah and Idaho the six-rowed type, both spring and winter, gives the best results, Utah Winter being the most profitable variety. In the Pacific States the six-rowed varieties, Bay Brewing and California Feed, are the most common, although some excellent barley of the two-rowed varieties, Chevalier and Hanna, is also produced.

The hooded and hull-less barleys (fig. 9) have proved successful in the semiarid regions of the West, where they are superior to any

FIG. 8.—Map showing the barley-producing areas in the United States, according to the census of 1900. Each dot indicates 2,000 acres of barley.

other type, especially in the high altitudes where little other grain matures. They also grow well under irrigation. Up to the present time they have not proved adapted to the humid sections of the East, as the excessive heat prevents the filling of the grain, and the moisture induces a weak straw that lodges readily.

SOILS ADAPTED TO THE CROP.

Barley requires a richer and more porous soil than wheat. It does best on well-drained loam soils, though the volcanic soils of the Northwest also give good results. This crop can be produced on sandy loam, but on this type of soil it is more susceptible to unfavorable climatic conditions than on silt or clay loam. In any case the soil should contain considerable humus and be in good physical condition.

Heavy, undrained clays are not adapted to the growing of barley. The roots of this plant are comparatively weak and do not penetrate such soils as readily as those of wheat. Soils of this type are especially undesirable for winter barley, for while a stand may usually be obtained, the crop is likely to be injured by the alternate freezing

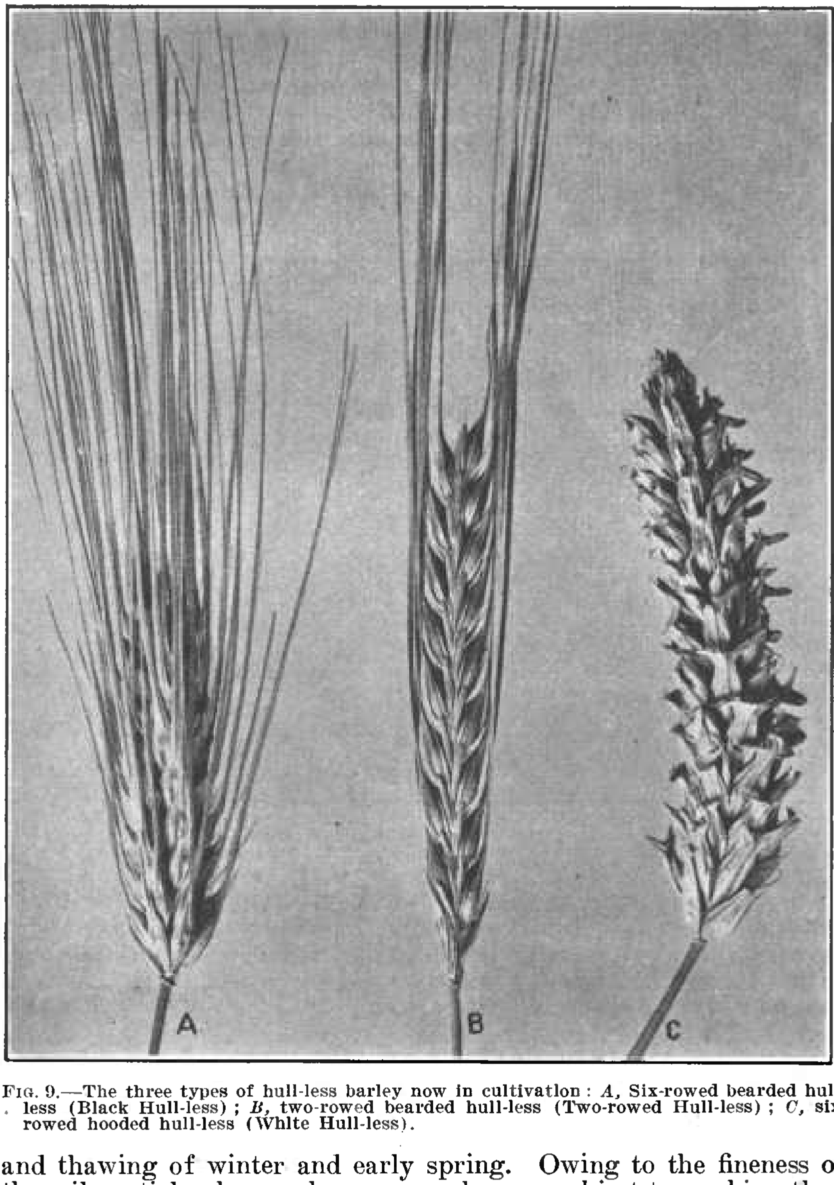

Fig. 9.—The three types of hull-less barley now in cultivation: *A*, Six-rowed bearded hull-less (Black Hull-less); *B*, two-rowed bearded hull-less (Two-rowed Hull-less); *C*, six-rowed hooded hull-less (White Hull-less).

and thawing of winter and early spring. Owing to the fineness of the soil particles, heavy clays are much more subject to washing than are the more porous loams. This washing exposes the roots of the young plants and is another cause of the failure of winter barley on this type of soil.

Well-drained, well-fertilized, gravelly clay soils have in some instances given good results in barley production. Loose, sandy soils, while easily prepared, are often deficient in plant food, while their inability to retain moisture makes them of doubtful value for the production of this crop. Though the moisture-retaining capacity may be largely increased by the addition of stable or green manures, the results will not be as satisfactory as those obtained on fertile loams. The greater ability of the loam to retain moisture insures better and more uniform germination during periods of drought, an important factor in the success of the crop.

In regard to the cultivation of barley on light, sandy soil, Mr. H. F. Blanchard, in charge of the cooperative grain experimental station at Modesto and Ceres, Cal., in a report says:

> On light, sandy soil the crop matures early, but the growth and stooling are poor and the heads small. On the heavier soils a greatly improved condition of growth and yield was shown.

Experiments conducted for several years at the Tennessee station showed the relative value of fertile and poor soils for barley culture. On fertile soil the yield averaged 65 bushels to the acre, while on poorer soil the yield was only 28.5 bushels.

Well-drained soil is essential for the best success with barley, as shown by experiments in Wisconsin. At Center drained land produced 36.72 bushels to the acre, while undrained land produced but 25.75 bushels. At Appleton the difference in favor of the drained land was 11 bushels to the acre.

FERTILIZERS AND MANURES.

General statement.—Barley is rather shallow rooted as compared with other cereals. As careful field observations show that the greater portion of the feeding roots are confined to the upper 6 inches of soil, the plant food should be near the surface and in an available form. This is one of the reasons why barley responds so readily to commercial fertilizers.

Barnyard manure.—Barnyard manure is the best fertilizer for barley, if it is available in sufficient quantity and is applied at the right time. It is superior to commercial fertilizers because in addition to the three essential elements—nitrogen, phosphorus, and potassium—it contains vegetable matter which improves the physical condition of the soil. On the loamy soils of the West the addition of vegetable matter is not so important, but on the clay soils of the South it has much to do with the success of the crop. Compact soils are made open and porous by the addition of barnyard manure, while the vegetable matter absorbs and holds moisture and prevents the drying and baking so common on such soils. It has been demonstrated, however, that plowing under coarse barnyard manure just before sowing barley seldom gives good results. Its effect on the physical condition of the soil is generally injurious, making it too open and porous. If plowed under some time before seeding, the plant food becomes available, the soil has time to settle, and the results are beneficial.

Green manures.—Where the soil is deficient in plant food and humus, the plowing under of clover, alfalfa, cowpeas, or other green-

manure crops some time previous to the sowing of barley is of benefit. In figure 10 the operation of plowing under cowpeas on a heavy clay soil is shown. Figure 11 shows the excellent growth of barley produced on a clay-loam soil after the plowing under of a green-manure crop. On lands already rich in nitrogen, plowing under these crops generally causes lodging, consequently they must be used with judgment. It is sometimes necessary to apply lime to correct the acidity due to the decay of green vegetation.

The reduced yields of grain in recent years have shown that the soils of the barley-producing areas are not inexhaustible. The barnyard manure produced is not sufficient to replace the fertility removed by the crops, and the use of green manures is advocated wherever possible.

At the Montana station, barley after peas gave a yield of 67.7 bushels, but after a grain crop it yielded only 35 bushels. At the

FIG. 10.—Plowing under cowpeas as a green-manure crop.

Utah station a crop of field peas plowed under increased the yield of barley from 7.22 bushels to 22.56 bushels.

Commercial fertilizers.—Where barnyard or green manures are not available, it is sometimes necessary to use commercial fertilizers in order to produce good crops of barley. The quantity and kind of fertilizer to be used depends on the requirement of the crop and the fertility of the soil. If the plants lack vigor and are of poor color, though climatic and other conditions are favorable, it is an excellent indication of a lack of nitrogen and phosphorus. In favorable seasons, if the grain fails to fill properly, the necessity of increasing the quantity of phosphates and potash is indicated. Frequently a complete fertilizer containing the three important elements, nitrogen, phosphorus, and potassium, may be necessary. Barley usually has large, heavy heads and consequently requires a stiff straw to prevent

the plant from lodging. The fertilizer should, therefore, contain a higher percentage of potash and phosphorus than of nitrogen.

Where barley follows cowpeas or other leguminous crops nitrogen can frequently be omitted from the fertilizer used, this element being furnished by these crops, but the phosphorus and potash will have to be supplied. In this case the application of 200 pounds of acid phosphate and 75 pounds of muriate of potash per acre will give good results. Raw rock phosphate may be used instead of the acid phosphate. It becomes available more slowly, but the beneficial effect extends over a much longer period. Raw rock phosphate does not increase the acidity of the soil as does the acid phosphate. Best results will be obtained from the use of the rock phosphate if it is added to stable manure before the latter is applied or if it is plowed under with a green-manure crop. Hon. W. D. Hoard, of Jefferson County, Wis.,

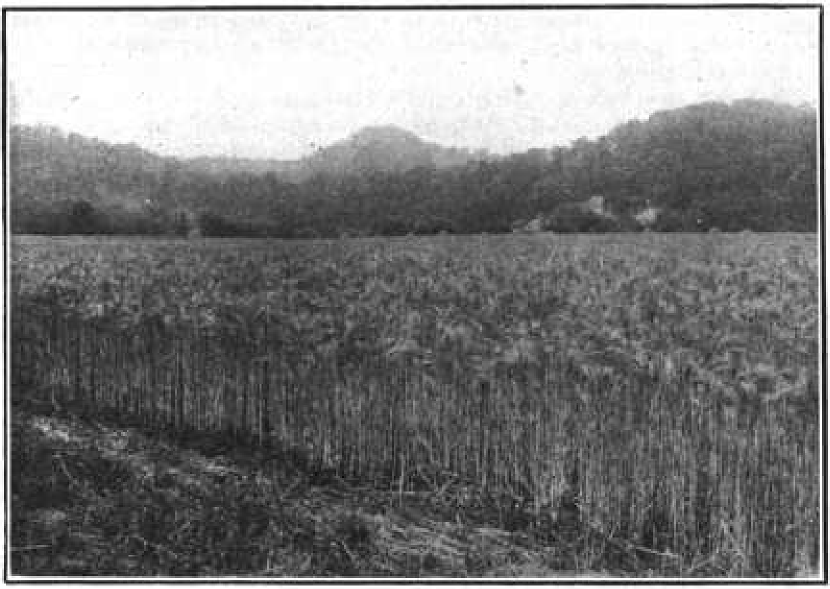

FIG. 11.—A field of six-rowed barley grown after a green-manure crop.

reports that on his farm a field of alfalfa which had been heavily manured two years previously was plowed up and sown to barley. A yield of 35 bushels to the acre was obtained. A similar field on which manure treated with raw rock phosphate was applied gave a yield of 51 bushels. The increase of 16 bushels was accredited to the use of rock phosphate.

On the clay soils of the Arlington Experimental Farm, near Washington, D. C., where large crops of cowpeas and rye are plowed under, excellent yields of barley are produced when 200 pounds of acid phosphate per acre are applied. At the Maryland station a complete fertilizer is used, which is mixed when needed. It consists of 300 pounds tankage, 200 pounds muriate of potash, 100 pounds nitrate of soda, and 1,400 pounds of 14 per cent acid phosphate. This is applied at the time of seeding at the rate of 300 to 400 pounds per acre.

A fertilizer that has given excellent results with grain crops in the Southern States is made up of 1,400 pounds of acid phosphate, 200 pounds tankage, 200 pounds muriate of potash, 100 pounds nitrate of soda, and 100 pounds dried blood. This is applied at the rate of 200 to 300 pounds per acre. In this fertilizer some of the nitrogen is immediately available, while the remainder becomes available slowly, thus furnishing material for growth throughout the season. Another mixture which has given satisfaction consists of 200 pounds acid phosphate, 50 pounds muriate of potash, and 50 pounds nitrate of soda, applied at the rate of 300 pounds to the acre. A light application of nitrate of soda after the plants are up will prove beneficial on poor soil.

At the Kansas station the application of about 200 pounds of sodium nitrate per acre gave an extremely vigorous growth and in one experiment nearly doubled the yield. At the Wyoming station an application of sodium nitrate to hull-less barley when the plants were several inches high increased the yield of hay from 2,457 to 4,918 pounds per acre.

When the seed is sown with a drill, commercial fertilizer is usually drilled in with the seed. Where the seed is sown broadcast, the fertilizer is generally applied by means of a special fertilizer attachment and is harrowed in before seeding. Instead of using a ready-mixed fertilizer it is sometimes advisable to purchase the ingredients and mix the fertilizer as it is needed.

The use of lime.—Acid soils are not adapted to barley culture. The Maryland station conducted experiments for a number of years with liming the soil for both barley and wheat and considers the application of 30 to 40 bushels of lime per acre most profitable. The Tennessee station obtained excellent results by applying 25 bushels of lime per acre the year previous to planting barley. Finely ground limestone may be used in place of burnt lime, but double the quantity is necessary to obtain the same results. Experiments conducted by the Rhode Island station on the liming of soils throughout the State indicate that considerable benefit is derived from the use of lime, even if applied directly before seeding barley.

Many farmers in the South obtain good results with clover after barley from drilling in 500 to 1,000 pounds per acre of ground lime just before sowing the barley. Drilling in the lime has also given excellent results on the Arlington Experimental Farm. When the lime is drilled in it is distributed much more evenly than when sown broadcast. Lime can also be distributed with a manure spreader.

BARLEY IN THE ROTATION.

EFFECT OF THE PRECEDING CROP.

In the greater portion of the United States barley has no fixed place in the rotation, but is generally sown without regard to the preceding crop. The market demand and the necessity for feed are the factors which usually influence the acreage.

The preceding crop has considerable influence on the yield of barley. At the Tennessee station it was found that winter barley after cowpeas were turned under yielded 56 bushels, while after corn

the yield was only 41 bushels. This indicates that on clay soils in the Southern and Central States, where the supply of humus is usually deficient, a different rotation is necessary from that practiced on the rich prairie or alluvial soils where barley, after corn, potatoes, or wheat, usually gives good results.

At the South Dakota station various rotations have been practiced for a number of years. These have given an excellent opportunity to study the effect of the preceding crop on barley. Table I shows the average yields per acre of barley in pounds of straw and bushels of grain in several rotations for three years.

TABLE I.—*Average yields of barley, both grain and straw, in 5 different rotations in a 3-year test at the South Dakota station.*[a]

Rotation.	Yield per acre.		Straw per 1 pound of grain.
	Straw.	Grain.	
Barley after wheat:	*Pounds.*	*Bushels.*	*Pounds.*
Wheat, barley, peas (plowed under), wheat, corn	1,983	35.75	1.16
Wheat, barley, peas (cut), wheat, corn	2,210	40.66	1.13
Barley, millet, wheat	1,920	34.66	1.36
Barley, peas (cut), wheat	1,630	35.00	.96
Average	1,936	36.52	1.15
Barley after flax:			
Flax, barley, millet, wheat, corn	2,075	40.20	1.07

[a] Bul. 79, South Dakota Agricultural Experiment Station.

In the rotation where flax preceded barley, the yield of barley was nearly 3 bushels greater than the average of the 4 rotations in which barley followed wheat, indicating that flax is a better crop than wheat to precede barley. Professor Chilcott states that the rotation in which barley followed flax was satisfactory for South Dakota.

Better yields are generally obtained where barley follows a cultivated crop than when it follows a small-grain crop. Valuable data have been collected by the Ontario Agricultural College on the effect of the preceding crop on barley. The average yield of barley grown after root crops was 27.75 bushels to the acre as reported by 337 correspondents, while 535 reported growing barley after other crops, with average yields of 24.5 bushels. The weight per bushel of cleaned seed was practically the same, 51.5 pounds. The average yield of barley for Ontario as reported by 1,015 correspondents was 22.2 bushels per acre. The barley grown after roots gave a yield of 5.5 bushels higher than the average. At the Ontario Agricultural College the best yields of barley were produced after potatoes, turnips, or carrots, especially when the land was plowed and well prepared for these crops.

In another experiment in Canada, barley, oats, and wheat were sown after summer fallow, wheat, and emmer. The largest yields were obtained where these crops were sown after emmer, and the poorest yields where they followed wheat.

COMMON ROTATIONS WHICH INCLUDE BARLEY.

A rotation which has given satisfaction in Minnesota consists of one year of corn; one year of barley, grass seed being sown with the grain; meadow and pasture as long as desired. Flax may take the place of corn, or may immediately precede it. A rotation planned to keep up the soil fertility consists of corn two years; barley one year, with grass or clover sown with it; hay two years, or meadow one year, and pasture one or more years. The grass land should be manured before breaking for corn.

In the Dakotas barley frequently follows wheat, the wheat stubble being disked and the barley drilled in. Where corn and oats are grown it may follow either of these crops. It generally does best, however, when following corn or where a leguminous or green-manure crop has been plowed under the preceding year. On many farms wheat is grown almost continuously, barley being grown only where a change of feed is desired, or when the land becomes weedy.

In Kansas, where alfalfa is grown, corn frequently follows that crop, while barley or other small grains follow corn. In Montana, where the growing of small grain predominates, a rotation which includes two years of clover followed by three crops of small grain, in the last of which clover is again sown, has given good results.

A 4-year rotation recommended for Wyoming is peas, grain, potatoes, grain. A good 6-year or 7-year rotation is as follows: Alfalfa, three years; fourth year, grain; fifth year, potatoes; sixth year, or sixth and seventh years, grain. In Utah, Nevada, and Idaho no definite rotation is commonly followed, and barley is sown after fallow or any crop. To obtain best results, however, a rotation should be practiced which includes leguminous crops. In the Pacific States barley generally follows summer fallow or wheat. In some localities barley is sown continuously on the same land for a number of years.

In a comparison between continuous cropping and the average of two 3-year rotations at 11 stations in the Great Plains area, Chilcott [a] found that under the former method barley averaged 21.1 bushels to the acre, while in the rotations the yield was 24.3 bushels, an increase of 3.2 bushels where rotation was practiced. This increase in yield was obtained without a corresponding increase in cost of production. The rotations which included barley were: (1) Barley on disked corn ground, oats on ground plowed early the preceding fall, corn on ground plowed early the preceding fall; (2) oats on spring-plowed land, barley on spring-plowed land, corn on spring-plowed land.

Rotation No. 1 gave an average yield of 25.9 bushels per acre at the 11 stations, and rotation No. 2 averaged 22.83 bushels. Table II gives the yields of barley obtained in these rotations at each of the stations, showing also the yield from continuous cropping for comparison.

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[a] Chilcott, E. C. A Study of Cultivation Methods and Crop Rotations in the Great Plains Area. Bulletin 187, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1910.

TABLE II.—*Yield of barley in two 3-year rotations compared with continuous cropping.*

Station.	Year.	Average yield per acre (bushels).		
		Rotation No. 1.	Rotation No. 2.	Continuous cropping.
Judith Basin, Mont	1909	42.7	39.1	45.2
Dickinson, N. Dak	1908	45.6	34.4	33.5
Do	1909	53.8	49.2	39.8
Edgeley, N. Dak	1907	18.3	10.6	10.2
Do	1908	31.9	26.0	25.0
Do	1909	33.1	32.7	27.0
Highmore, S. Dak	1906	37.7	29.2	....
Do	1907	25.0	28.3	30.2
Do	1908	30.0	29.9	29.8
Bellefourche, S. Dak	1909	47.1	28.1	23.8
North Platte, Nebr	1907	30.6	40.2	39.0
Do	1908	24.9	22.3	19.6
Do	1909	21.5	18.5	....
Akron, Colo	1909	24.9	22.2	19.7
Hays, Kans	1908	12.3	9.2	5.8
Garden City, Kans	1909	5.1	5.7	2.4
Dalhart, Tex	1909	0	0	0
Amarillo, Tex	1908	7.5	8.1	7.9
Do	1909	0	0	0
Average	....	25.9	22.83	21.1

The Superintendent of the North Platte, Nebr., substation says in a recent publication:[a]

A rotation that seems well adapted to our conditions here is as follows: Summer tillage, winter wheat, corn, spring grain, cane. Summer till and sow winter wheat; disk and fall plow the wheat stubble for corn the next year; disk the corn stubble for a spring grain—oats, wheat, or barley; apply manure during the winter, disk in the spring and plow for cane, which completes the rotation.

CLEARING THE LAND OF WEEDS.

Owing to its early maturity, barley is an excellent crop for clearing the land of weeds, as it is cut before they mature seed. After the crop is removed the land can be plowed or disked, thus destroying the weeds that are growing in the stubble. Further cultivation will kill any that survive this treatment or appear later. In the semiarid regions this added cultivation is of considerable value in conserving the moisture for the succeeding crop.

EFFECT OF BARLEY ON THE LAND.

Experiments conducted at the South Dakota station indicate that barley as a crop is exhaustive to the land. A crop of barley of 40 bushels or 1,920 pounds of grain and 2,200 pounds of straw removed from the soil 54.14 pounds of nitrogen, 20.93 pounds of phosphoric acid, and 49.35 pounds of potash, a total of 124.42 pounds. Comparing this with other crops, we find that a 30-bushel crop of corn, weighing 1,680 pounds, removed a total of 113.99 pounds of these three elements; a 15-bushel wheat crop, weighing 900 pounds, removed 59.11 pounds; and a 45-bushel oat crop, weighing 1,440 pounds, removed 97.77 pounds.

[a] Bulletin 109, Nebraska Agricultural Experiment Station.

The comparative quantities of the elements removed from the soil by the grain and the straw of a 40-bushel barley crop were found to be as follows: Nitrogen, 28.99 and 25.15 pounds; phosphoric acid, 15.17 and 5.76 pounds; and potash, 9.22 and 40.13 pounds, respectively. From these figures it can be seen that the grain removed 1.1 times as much nitrogen and 2.5 times as much phosphoric acid as the straw. The straw, however, removed more than 4 times as much potash as the grain.

It has been estimated that under California conditions a 40-bushel crop of barley removes 46 pounds of nitrogen from the soil, or 1.15 pounds to the bushel. A 60-bushel crop of oats removes 55 pounds of nitrogen, while a 35-bushel crop of wheat removes 59 pounds. In South Dakota it was found that a 40-bushel crop of barley removed 1.35 pounds of nitrogen per bushel, or 0.20 pound more than in California.

ALKALI RESISTANCE OF BARLEY.

Experiments conducted by the California station demonstrated that barley is more resistant to alkali than wheat, as it withstood considerably more carbonate of soda and common salt. It was found that barley grew to a height of 4 feet in land containing more than 12,000 pounds of carbonate of soda per acre in the upper 4 feet, and produced 1 ton of hay per acre on a soil containing more than 5,000 pounds of common salt in the same depth. This station recommends that where the salt exceeds 5,000 pounds in the surface 4 feet, barley should be given the preference over wheat. In the irrigated district near Roswell, N. Mex., according to a correspondent, better results were obtained when winter barley was grown on alkali land before seeding to alfalfa.

DROUGHT RESISTANCE AND WATER REQUIREMENTS.

With the exception of the hooded and hull-less varieties, barley is not generally considered drought resistant. It is most affected when the plants are small and when the heads begin to fill. This accounts for the shortness of the straw following a dry spring and the poorly filled heads after a dry period during heading. The hooded and hull-less barleys will generally produce a crop with less rainfall than will spring wheats, with the possible exception of those of the durum type.

Experiments conducted by the Ontario Agricultural College demonstrated that the water requirements of the various small-grain crops at that place were: Wheat, 22.6 inches; oats, 21.15 inches; and barley, 18.52 inches. Previous to July 20, barley had used 2.25 times and oats 2.57 times as much water as had fallen in rain. The additional water necessarily came from the soil moisture.

At the South Dakota station the relative quantities of moisture needed to produce the various crops were determined. It was estimated that under the South Dakota conditions it required 464 tons of water to make 1 ton of dry matter of barley as compared with 271 tons for corn, 453 tons for wheat, and 504 tons for oats. It was estimated that corn used 4.63, oats 7.49, wheat 5.76, and barley 7.59 acre-inches of water. From the results obtained at this station barley was believed to be an exhaustive crop on soil moisture.

King, in his experiments at the Wisconsin station, estimated that under Wisconsin conditions it required 4.09 acre-inches of water to make 1 ton of dry matter of barley as compared with 4.44 acre-inches for oats and 2.39 acre-inches for corn. The Colorado station found that in that State barley required less moisture than oats.

PREPARATION OF THE LAND.

GENERAL STATEMENT.

Barley is grown over such a wide area and under such a diversity of conditions that definite rules for its cultivation can hardly be given. The thorough preparation of the seed bed is essential under all conditions, as on this depends a large part of the success of the crop.

Plowing should be done the fall previous or a considerable time before seeding. This allows a complete settling of the soil and improves its water-holding capacity. Many failures have resulted from planting barley on newly plowed ground, especially when a dry season followed. The crop seldom does well on newly broken sod; but when sod land is to be planted best results will be obtained if it is broken shallow and laid flat rather than set on edge, as is commonly done. Breaking should be done while the grass is fresh and green, as decomposition then sets in rapidly and the vegetation and roots soon decay. Plowing under vegetation when the plants and roots are tough is injurious, as their slow decay renders the soil too open.

No soil should be plowed when very wet. The shearing action of the plow upon the bottom of the furrow is likely to form an almost impervious layer or "plowpan" by compacting the soil particles. Unless the depth of plowing is varied from year to year this layer is likely to injure the growth of crops that follow. By gradually changing the depth of plowing each year new soil is brought to the top and mixed with the surface soil without injuring its yielding capacity.

In some portions of the United States the ground is seldom plowed for barley where it follows a cultivated crop, but is simply cross or double disked and harrowed. When the soil is in good physical condition good crops may be obtained by this method. A disk harrow in operation on corn ground is shown in figure 12.

PREPARATION IN THE EASTERN AND CENTRAL STATES.

Where possible, barley should follow a cultivated crop. As soon as the previous crop is removed in the fall the ground should be deeply plowed and left rough. As early in the spring as possible the land should be double disked, either crossing or lapping half. If the soil is rough and cloddy a plank drag (fig. 13) should be used to break the clods. In extreme cases a light roller should first be used. The disk harrow or plank drag should be followed by the smoothing harrow to make a fine seed bed. In a cold, backward spring this treatment will aid in warming up the soil.

If the land is not plowed until spring, the soil sometimes dries out so rapidly that it becomes hard before the plowing can be completed. If the land is disked as early as possible in the spring a mulch is formed that prevents excessive drying, so that the land remains in

good condition for plowing for some time. The harrow should follow the plow as rapidly as possible, as this prevents the baking or hardening of the furrow slice. Further preparation should be the same as on fall plowing. Barley is frequently sown in this section on land which has been thoroughly disked but not plowed.

PREPARATION IN THE GREAT PLAINS AREA.

In the Great Plains area, where a most important factor in crop growth is the conservation of moisture, all soil preparation and cultivation should have that end in view. The land should be plowed in the fall and left rough, or plowed in the spring and backset in the fall. This allows the soil to absorb the winter rains and hold the snow, thus retaining the moisture which falls. The soil crumbles into a fine condition and does not pack as when smoothed with a

FIG. 12.—The cutaway disk harrow as it is used in the preparation of corn land for small grain.

harrow. It also blows less when left rough. In the spring the land should be double disked, lapping half, thus making a comparatively level surface. The harrow should follow the disk in order to form the mulch so essential to the conservation of moisture.

In portions of the West it may be necessary to subsoil and to use implements to pack the subsurface. A corrugated roller, a heavy disk harrow with the disks set straight, or a heavy spike-tooth harrow can be used to advantage for crushing clods and packing the soil. A common smooth roller is apt to make the soil too compact unless it is followed immediately by the harrow to loosen the surface.

In some portions of the Great Plains it is believed best to leave the stubble unplowed until early spring, in order to hold the winter snows and prevent the blowing of the soil. There is danger, however, when plowing is not done until spring, that unfavorable weather conditions may delay seeding.

PREPARATION IN THE PACIFIC STATES.

Barley in the Pacific States is sown in both winter and spring, depending on the locality and season. The preparation of the soil varies with the method and time of seeding.

In California, in the valleys subject to overflow, barley is sown late in the spring. The land should be plowed deep and the plow followed immediately by the harrow, so that a good firm seed bed may be prepared. When the land is plowed and the seed sown in the same operation, the harrow should follow to make a good seed bed. Where barley is sown after wheat as a winter crop, the wheat stubble should be double disked as soon as the crop is removed. This breaks down the stubble, covers the weed seeds, and renders the soil receptive to the fall rains. Immediately following the fall rains the land should be rather deeply plowed and well harrowed.

FIG. 13.—A plank drag, a useful tool in preparing the seed bed for barley.

In some localities it is occasionally desirable to summer-fallow for barley, in order to clean the land of weeds or to rest it after a long period of continuous cropping. When the land is foul with weeds, the method of cleaning practiced upon the experimental farms of the Department of Agriculture in California has given excellent results. Immediately after the removal of the previous crop the land is disked and harrowed. After the fall rains, when the weed seeds are well germinated, the land is plowed to a depth of 4 inches and immediately harrowed. After the winter rains the land is plowed to a depth of 8 inches, in order to bring to the surface the weed seeds not exposed during the previous plowing, and is again harrowed. During the summer the land is kept free from weeds by occasional cultivations. At seeding time in the fall or winter the land is deeply disked, the seed sown, and the land harrowed as rapidly as sown. To obtain the best results the land should be harrowed just before the barley comes up, in order to kill the last crop of weeds.

Where land is fallowed it is usually plowed deep and a surface mulch maintained by the occasional use of the harrow, which prevents a crust from forming and destroys the young weeds. The land is again harrowed just before seeding. This method has many advocates, as it requires less labor than the one just described.

Another method successfully used by a number of farmers in the semiarid portions of Washington is adapted to a large area in the Pacific Northwest, where conservation of moisture is necessary. The land is deeply plowed in the fall and left rough. This deep plowing is less expensive in the fall, when other work is less urgent, than in the spring. The plowing also destroys a large number of weeds, and the loose soil absorbs and stores the moisture from the winter snows and rains. As early in the spring as possible, when the young weeds and volunteer grains appear, the land is plowed shallow, not more than half the depth of the fall plowing, and immediately well harrowed. This shallow plowing is light work for the team, and the land can rapidly be prepared for seeding. The harrowing kills a large number of young weeds and forms a mulch which conserves the soil moisture.

PREPARATION FOR WINTER BARLEY.

Where winter barley is grown various methods of soil preparation are followed. A common method is to sow it after a cultivated crop for which the land has been manured and plowed. Where barley follows corn, the corn is cut and removed from the field or placed in large shocks in straight rows. The ground is then deeply disked both ways and harrowed, thus obtaining a good surface and a firm seed bed. Where winter barley follows early potatoes or a grain crop, as soon as these crops are removed the land should be plowed shallow or disked deep and harrowed. By continuing the cultivation throughout the summer a mellow seed bed free from weeds is obtained and the mulch formed retains the moisture in the soil. A shallow disking and cross harrowing before planting insures a perfect seed bed. On the compact clay soils of the Eastern and Southern States excellent crops of winter barley can be grown after cowpeas turned under the latter part of August. If lime has not been applied for several years, an application of 20 to 25 bushels per acre should be made. This should be thoroughly mixed with the soil, either by drilling or by means of the disk and smoothing harrows. In dry seasons, when the soil is cloddy, the clods may be crushed by the corrugated roller followed by the plank drag. If the smoothing harrow is then used an excellent seed bed is formed. The use of the disk drill in seeding still further improves the surface soil.

EFFECT OF SOIL TREATMENT ON THE YIELD.

At the Pennsylvania station six different methods of soil preparation were tried in duplicate. In three of the methods the soil was plowed, while in the remaining three it was simply cultivated. Manchuria (Mansury) barley was sown on all the plats at the rate of 8 pecks per acre. The average yields of grain and of straw obtained from each of the methods of soil preparation are given in Table III.

TABLE III.—*Yields of barley, both grain and straw, at the Pennsylvania station* [a] *with different methods of soil preparation.*

Method of soil preparation.	Average yield per acre.	
	Grain.	Straw.
	Bushels.	*Pounds.*
1. Plowed 7 inches deep and rolled	21.8	980
2. Plowed 7 inches deep and harrowed 3 times, ordinary conditions	21.7	1,240
3. Plowed 7 inches deep, harrowed 3 times; seed bed finely pulverized	21.2	935
4. Not plowed; harrowed twice, surface but slightly disturbed	15.7	1,090
5. Not plowed; cultivated once with 8-shovel corn cultivator and harrowed once; surface rather poorly pulverized	15.1	850
6. Not plowed; cultivated 3 times with 8-shovel corn cultivator and harrowed 3 times; surface soil fairly well pulverized	17.9	1,020
Average plowed	21.6	1,051
Average not plowed	16.2	987
Increase due to plowing	5.4	64

[a] Annual report for 1891, p. 48.

The yield on the plowed plats was considerably larger than that on the unplowed, but no advantage was derived from additional labor expended in either case over the plat which was plowed and harrowed three times. Similar results were obtained in experiments conducted at the Utah station, where excessive cultivation reduced the yield.

Table IV gives the yield in bushels to the acre as the result of one year's trial of barley in Kansas, at the Fort Hays Branch Experiment Station, with different methods of soil preparation. The land in these experiments was all plowed alike and the conditions were similar, with the exception of the later treatment.

TABLE IV.—*Yield of barley at Hays, Kans., with different methods of soil preparation.*[a]

Number of acres.	Treatment.	Date.		Yield per acre.
		Planted.	Cut.	
				Bushels.
7	Harrowed once after plowing	Mar. 30	July 15	28.12
7	Packed after plowing	...do.....	July 16	30.01
7	Harrowed and packed after plowing	...do.....	July 18	29.35
7	Harrowed and disked after plowing	Mar. 28	...do.....	30.35
7	Not treated after plowing	...do.....	July 19	26.08

[a] Bul. 128, Kansas Agricultural Experiment Station.

The highest yield, as shown in the table, was produced on the field which was both harrowed and disked after plowing, though packing after plowing gave nearly the same results. These two treatments each produced yields 4 bushels higher than that of the untreated field, while all the treatments resulted in some increase in yield. Too much emphasis, however, should not be placed on the yields obtained from the different treatments, as it requires a number of years' trial to demonstrate which is the most profitable method of soil treatment in any locality.

Chilcott[a] gives the average yield of barley obtained in 1907–1909 from various methods of tillage at 11 different stations in the Great Plains area, located in Montana, North Dakota, South Dakota, Colorado, Nebraska, Kansas, and northern Texas. Where the land was continuously cropped under ordinary methods, the average yield obtained was 21.11 bushels; where the cropping was continuous, but moisture-conservation methods were practiced, 22.88 bushels; and where alternate cropping and summer tillage were practiced, 30.74 bushels. While summer tillage increased the yield of barley, and in seasons of drought would prevent failure, under ordinary conditions the increased cost due to plowing, disking, and harrowing proved too expensive for the increased results obtained.

SOWING THE SEED.

Kind of seed to sow.—The proper selection of barley for seed is important, but is a factor in the production of the crop which is often neglected. Where the grain is very small or imperfect the vitality is generally poor. Even though these small grains germinate, the plants produced are weak and may not survive an unfavorable season. If they mature, they generally produce grain of inferior quality. The lateral grains in the six-rowed barley during unfavorable seasons are light and chaffy and will not germinate, hence they should be removed and only plump seed sown. The stand will be considerably improved by the removal of this inferior seed. It is generally true that large, plump seeds contain larger germs than small ones and produce stronger and more vigorous plants, which rapidly develop large, healthy root systems. This rapid development of the root systems aids them to resist drought or other unfavorable conditions. Where a well-established root system is developed early in the growth of the plant, the maximum quantity of moisture and plant food for its successful development is supplied. On the Great Plains, where barley is injured by the blowing of the soil, a plant with a strong root system can better retain its hold than a weak-rooted one.

Testing the germination.—If, owing to unfavorable weather conditions during the ripening period or after harvest, the seed is of doubtful viability, several lots of 100 grains each should be taken from different parts of the seed bin and tested in plates of moist sand or earth, or between sheets of moist blotting paper. If less than 90 grains of each lot show vigorous germination, better seed should be obtained or the quantity of seed sown per acre increased.

Time of seeding.—Barley should be sown as soon as danger from severe frosts is over and the soil is sufficiently warm and dry to prepare a good seed bed. This date varies in the Northern States from April 1 to May 15, according to the locality and season. In the central portion of the United States planting begins as early as March 1 and continues until the middle of April. In the Southern and Central States where winter barley is sown, seeding between September 15 and

[a] Chilcott, E. C. A Study of Cultivation Methods and Crop Rotations in the Great Plains Area. Bulletin 187, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1910.

October 15 gives best results. Where the crop is liable to attack from insects, October 1 to 15 is preferable. If intended for pasture, however, the seeding should be done early in August. In the Southwestern States seeding is most successful when done in November, December, and January. In California the seeding of barley extends from November to March, according to the elevation, location, and season.

At the Kansas station, in 1905 and 1906, experiments were conducted on the seeding of barley on various dates. In 1905 seeding began on March 10 and was continued on March 14 and 30, April 13, 20, and 27, and May 6 and 12. The seeding of March 30 gave the best yield, 25.69 bushels, while that of May 12 gave the lowest yield, 6.64 bushels, only about one-fourth as much as the seeding of March 30. In 1906 the experiment was repeated, the seeding beginning February 1. Seed was also sown February 19, March 29, April 10, 21, and 28, and May 11. Owing to favorable weather conditions the seeding of February 1 gave the largest yield, 36.55 bushels, and that of February 19 the next highest, 30.21 bushels, while the lowest yield obtained, 5.83 bushels, was from the seeding of May 11. In general, however, seeding as early as February is not advisable in Kansas.

Rate of seeding.—The rate of seeding depends on the rainfall, the fertility of the soil, and the variety. In the humid regions seeding at the rate of 8 pecks to the acre gives the best results, while in the semiarid regions of the West and Southwest 4 to 6 pecks are sufficient. Thick sowing, even under ideal conditions, while it produces a heavy stand, does not always give the best results, as when the plants are crowded there is a tendency for the grain produced to be small.

At the North Platte, Nebr., substation, 4 varieties of common barley were sown at 4 different rates, 2, 4, 6, and 8 pecks per acre, on two different dates in 1907, March 20 and April 3, and on one date in 1908, April 6. The highest average yield for the three dates of seeding was obtained from the 6-peck rate. With the hull-less barley sown on the same dates at the rates of 2, 4, and 6 pecks to the acre, the 4-peck and 6-peck rates gave practically the same yields, about 2.5 bushels more than the 2-peck rate.

Method of seeding.—The best method of sowing barley is in drills 6 or 8 inches apart (fig. 14). This method insures even distribution of the seed and places the grain at the proper depth for germination, thus promoting a perfect stand. Grain in drills can withstand a dry season better than that sown broadcast, as the plants develop a deeper root system, enabling them to absorb more plant food and moisture from the soil. Where the crop is drilled there is a better opportunity for air and sunlight to penetrate, an important factor during a moist season. When barley is sown broadcast and harrowed in, it is covered to various depths and germinates unevenly. While a good stand may be obtained, the plants from seed not sufficiently covered frequently fail to survive a long dry period following spring sowing, or a severe winter after fall sowing.

At the North Platte, Nebr., substation, drilled barley yielded 27.7 bushels to the acre, while that sown broadcast gave a yield of only 17.7 bushels, an increase of 10 bushels in favor of drilling. As the season was dry, the drilled barley germinated quicker and made a

better stand than that sown broadcast. In an experiment conducted by the Wyoming station at five substations, at elevations ranging from 4,000 to 7,200 feet, it was found that barley sown in 8-inch drills, 1 inch apart in the row, gave the largest yields.

Depth of seeding.—Little attention is generally paid to the depth at which barley is sown. It varies from a fraction of an inch when sown broadcast to several inches when sown with a drill. The proper depth depends on the moisture and the physical condition of the soil. Usually, seeding at a depth of 2 to 3 inches will give best results. On compact soils the former depth is sufficient.

In an experiment at the North Dakota station [a] in seeding barley at depths varying from 1 inch to 4½ inches, it was found that seeding at a depth of 3 inches gave the best results. In an experiment

FIG. 14.—A grain drill and a well-prepared seed bed, two important factors in barley culture.

at the Minnesota station in seeding barley at different depths from one-half inch to 3 inches it was found that the highest yield of grain and straw was obtained from seeding at depths of 1 to 2 inches. The deeper seeding required one day longer to mature. In another experiment at this station it was found that barley covered to a depth of 1 inch or less germinated better and tillered more than that planted deeper. In still another test the seed was sown at depths ranging from three-fourths of an inch to 3½ inches. The shallowest planting gave the largest yield of straw, 2,120 pounds, but the smallest yield of grain, 24.5 bushels, while the deepest planting gave a yield of 1,770 pounds of straw and 31.9 bushels of grain.

[a] Bulletin 39, North Dakota Agricultural Experiment Station.

TREATMENT AFTER SEEDING.

CULTIVATION.

Barley, as a rule, is not cultivated, though in the semiarid regions or in seasons of drought in the more humid ones barley sown in drills will be benefited by cultivation with a spike-toothed harrow or weeder. This loosens the surface soil, aids in holding the moisture, and destroys small weeds. Barley sown broadcast, however, can not be cultivated without considerable loss.

In an experiment at the Akron, Colo., substation, two plats were sown to barley in 8-inch and 12-inch drills. The same rate of seeding per row was used. One plat of each width of planting was cultivated with a harrow, while the other was not. The cultivated plat in 8-inch drills yielded 1.2 times as much straw and 1.4 times as much grain as the uncultivated plat. The cultivated plat in 12-inch drills yielded 1.5 times as much straw and grain as the uncultivated plat. The plants on the cultivated plats were 2 to 3 inches taller than those on the uncultivated ones. On the experiment farms at Modesto and Ceres, Cal., fields of barley were harrowed just before the grain came up, and many weeds were killed by this cultivation. After the winter rains were over the cultivation was continued after every shower until the grain was so high as to be injured by the harrow. These harrowings were of much benefit to the growing grain. At the Highmore, S. Dak., substation, the harrow is used to preserve the soil mulch before the plants appear. After the plants are an inch or more in height the weeder is used until the grain is 6 inches high. This treatment is efficient in destroying a large number of weeds as well as in conserving the moisture. At the Wyoming station a thorough harrowing to break the soil crust and conserve the moisture is considered an excellent practice during early growth.

IRRIGATION.

In the Rocky Mountain States considerable barley is grown under irrigation. The proper quantity of water to apply to obtain the best results is a question of considerable importance.[a] Where the supply is abundant, farmers are apt to use more water than is necessary. Surface indications are not safe guides to follow in the irrigation of barley, as a soil may appear to be dry on the surface and yet contain sufficient moisture for the growth of the crop.

The Nevada and Wyoming stations have conducted numerous experiments in the irrigation of barley, and valuable data have been obtained. In experiments at the Nevada station in the past two years some plats were given what was considered an excessive quantity of water, and others an insufficient supply. Table V gives the number of irrigations, depth of water applied, and the yield produced.

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[a] A thorough discussion of the proper use of water for the irrigation of grain crops can be found in Farmers' Bulletin 399.

TABLE V.—*Yield of barley obtained from no irrigation and from one and two irrigations, and the application of various depths of water at the Nevada station in 1908 and 1909.*

Number of irrigations.	Depth of water in feet.	Yield per acre.		Yield per acre-foot of water.	
		Pounds.	Bushels.	Pounds.	Bushels.
2	0.843	1,432	29.84	1,700	35.40
2	.832	1,892	39.43	2,280	47.40
1	.386	1,677	34.95	4,360	90.60
1	.579	1,127	23.49	1,940	40.57
None		1,080	22.50		

This table shows that the excessive application of water in irrigation gave a much lower yield than where a moderate quantity was used, and that no irrigation gave almost as good a yield as where an excessive supply was given in one irrigation. The yield per acre-foot from one moderate irrigation was much greater than that from two irrigations.

In a series of experiments at the same station on the quantity of water necessary to produce farm crops, water was applied from 2 to 8 times to the barley crop. The largest yield, 58.5 bushels, was obtained from 2 irrigations, and the application of water to a depth of 0.99 foot. The barley irrigated 8 times, with a total application of 1.34 feet of water, yielded only 33.8 bushels. Barley not irrigated yielded 34 bushels, or slightly more than that irrigated 8 times. The conclusion arrived at was that in ordinary practice fully twice as much water is applied as is required for best results with barley.

Experiments in the irrigation of barley at the Wyoming station showed that this crop varies in yield and quality according to the quantity of water applied. The highest yield was harvested from the plats receiving 16 to 20 inches of water, applied in 3 irrigations. The quality for brewing purposes was injured by the application of too much water. The most satisfactory method of irrigation was by means of furrows 16 inches apart, as compared with the flood and check methods. The first cost was higher, but the labor of later irrigations was less than with either of the other methods. In a number of experiments conducted at different stations throughout the State the beneficial effects of irrigation were noticeable in the increased tillering and in the number of large, well-matured heads. In every case the increased yield demonstrated the value of irrigation over the nonirrigated plats.

HARVESTING THE CROP.

Time to harvest.—Barley ripens in the Southern States from May 1 to June 1. In the Central States it generally matures in June and July, and in the Northern States in July and August. In the Pacific States the time of ripening varies from May 15 to September 1, according to the elevation and the time of seeding. Unfavorable weather conditions may extend the season, but usually a few days' difference in seeding causes but a slight variation in the time of ripening.

Barley requires more judgment in harvesting than almost any other cereal. If harvested too early the appearance and value of

the grain are injured by shrinkage. If allowed to become overripe the heads bend over and shatter badly during harvesting, while in humid regions the grain becomes discolored.

The hardness of the grain when pinched between the thumb and first finger will indicate when the crop is ready to harvest. If the grain can just be dented with the nail, it is in the hard-dough stage and should be cut immediately. In unfavorable seasons, when the grain ripens unevenly, it is better to cut when most of the heads are ripe, even though there is some loss from shrinkage. If the grain is intended for brewing purposes it should not be cut too early, as it increases in value until the grain is dead ripe. Barley should not be cut when wet with dew or rain, as the bundles dry out slowly. At the Maryland station grain of better color and higher weight per bushel was obtained when cut when the straw was all ripe and the grain in the dough stage than from earlier or later cutting.

Method of harvesting.—Barley is usually harvested with the binder. In the semiarid region the header is sometimes used, and in the Pacific and Rocky Mountain States the combined harvester, though in some seasons the straw is too short for the use of either of these machines.

In dry seasons when the straw is short it can sometimes be cut with the binder by lowering the platform and lowering and tilting the reel. Where this is not practicable, the crop can frequently be cut to advantage with the mower. In this case it should be harvested before it is fully ripe in order to prevent shattering from the trampling of the horses. The grain cures readily, and can be bunched with the horserake with little loss. Cocks can then be made which, if carefully topped, will shed water quite readily.

Shocking and stacking.—If weather conditions are favorable, it is best to let the bundles dry before shocking. They should then be set up in oblong rather than round shocks, as the oblong shocks allow better ventilation. Capping the shocks is usually practiced, but they should not be capped when wet. In sections of the West where high winds prevail, barley is usually shocked without capping, as the caps blow off and the quality of the grain in such sheaves is injured by lying on the ground.

Barley while in the shock is frequently injured by heavy rains. Moisture not only discolors the grain, but if excessive may also cause it to sprout. Opening the shocks is the only remedy. The common method is to scatter the bundles on the ground, but as there is danger that the grain in contact with the soil will absorb sufficient moisture to cause further injury, the method practiced in Germany and by farmers in some localities in the United States is recommended. When the shocks are opened the first bundle is laid flat on the stubble; the second and succeeding bundles are then laid across the middle of the preceding ones, the butt ends resting on the ground and the heads projecting beyond the bundles upon which they rest, the object being to keep the grain off the ground. By lapping the bundles in this way (fig. 15) the heads are kept off the ground and are exposed to the action of the air, so that they dry out quickly. Even though rained on while in this position, they will soon dry and will be damaged less than if lying on the ground.

Barley should not be stacked until the grain has at least partly cured in the shock, especially when the bundles contain weeds or grass. Insufficient curing in the shock may cause heating, discoloration, and germination during the sweating process in the stack. If the grain is fully ripe when cut it can be stacked in a few days. In the semiarid regions some growers stack as soon as the crop is cut.

The general opinion among the most successful growers in the West is that stacking gives better results both in color and soundness, two important factors in regulating the price of barley. Barley is generally more difficult to stack than wheat or oats because of the shortness of the straw. As it does not shed water as readily as wheat or oats, it is better to stack in slender, circular stacks, rather than in the extremely large ones commonly seen in the West.

Shock thrashing versus stack thrashing.—Considerable difference of opinion exists as to the relative merits of thrashing from the shock and from the stack. The difference in cost is usually the deciding factor. On the smaller farms, where practicable, stacking after curing in the shock is unquestionably the best method, as a better

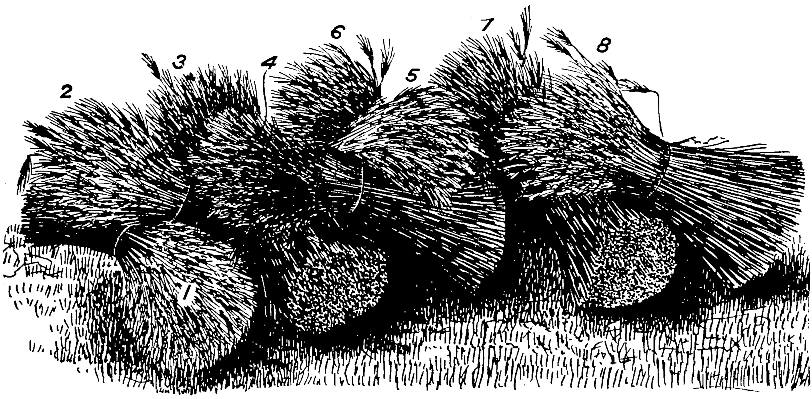

FIG. 15.—Method of laying wet bundles to dry in order to prevent the sprouting of the grain. The numbers indicate the order in which they are laid.

quality of grain is produced. On the larger farms, where the crop is grown on an extensive scale, the thrashing is generally done from the shock. The comparative cost of thrashing barley from the stack and from the shock was carefully computed in Minnesota. In Norman County the cost of thrashing from the shock was 4.4 cents per bushel, and of stacking and thrashing, 5.4 cents. In Rice County thrashing barley from the shock cost 4.8 cents per bushel, and from the stack, 5.9 cents. While the cost of thrashing from the stack is generally 1 or 2 cents a bushel more, many farmers prefer to stack on account of the better color and quality of the grain. A thrashing scene in Minnesota is shown in figure 16.

Thrashing.—If the grain stands in the shock for some time, the cap sheaves often become discolored from rains or heavy dews. If these are thrashed with the bundles which have been protected, the discolored kernels will be mixed with the brighter grain and the market value of the whole lessened. If the cap sheaves are thrashed separately the discolored grain may be kept for feeding on the farm, as color does not materially affect the feeding value; but when barley

is long exposed to the weather some loss is occasioned by the leaching out of some of the soluble constituents of the grain.

Care should be used in thrashing. If the concaves are set too close many grains will be cracked or broken and the awns will be broken off too close to the grain, thus considerably reducing its viability and market value.

STORING THE GRAIN.

Barley should be carefully housed after thrashing, as it rapidly absorbs moisture and is easily influenced by changes in temperature. If stored in damp bins it becomes musty, and as odor is one of the factors which influence the market value, dampness and mustiness should be avoided. Dampness is also likely to injure the germination of the grain, either for malting or for seed. When barley is well cured before thrashing and is stored in cool, dry bins, it passes through the sweating process and remains bright, clean, and sweet. If the grain becomes damp in any way it should be shoveled over

FIG. 16.—Thrashing barley from the shock in Minnesota.

several times or changed to another bin in order to dry it thoroughly. A prominent grain grower in Maryland dries damp or poorly cured grain by forcing a current of air through it from the bottom of the bin by means of a fan driven by a small engine. The fan is usually run for a day or two, but after the current is established the fan can be stopped. This method avoids the necessity of rehandling the grain when it becomes damp.

VARIETY TRIALS.

RESULTS OF EXPERIMENTS IN DIFFERENT STATES.

Experiments in the cultivation of barley in the United States have been conducted for many years, but it is only recently that definite results have been obtained or accurate data collected. Many varieties are now grown at the various experiment stations and farms, in order to determine those best adapted to the different localities. The results of some of these variety trials are reported in the following pages.

TRIALS IN THE EASTERN, CENTRAL, AND SOUTHERN STATES.

Experiments conducted at various places in the States of New York, Pennsylvania, Ohio, Indiana, and Illinois indicate that the six-rowed varieties of barley are the most profitable. Definite results have been reported in only a few instances. In Maryland, Virginia, Kentucky, and Tennessee, and in the southern portions of Ohio, Indiana, and Illinois the six-rowed winter barley gives excellent results.

TRIALS IN THE NORTH CENTRAL AND PLAINS STATES.

Wisconsin.

At the Wisconsin station a large number of varieties of barley have been tested. Of late years, however, only four pedigreed six-rowed varieties have been extensively grown. These are Oderbrucker, Manchuria, Silver King, and Golden Queen, which rank in yield in the order given. The average yield of Oderbrucker for the 5-year period from 1905 to 1909 was 51.2 bushels; of Manchuria, 46.2 bushels; of Silver King, 41.9 bushels; and of Golden Queen, 32.3 bushels. The average number of days required to mature these varieties was ninety-four, and the average weight per bushel 45 to 47 pounds. Oderbrucker barley has been extensively distributed throughout the State. Its high yielding power has put Wisconsin in the front rank as a barley-producing State.

Minnesota.

At the Minnesota station the six-rowed barleys yield best. The average of the 10 best six-rowed varieties in 1908 was 43.7 bushels, while the 10 best two-rowed averaged but 36.3 bushels. The Manchurian barleys are at their best in that portion of the State, several selections yielding 45 to 50 bushels per acre. Among the best two-rowed varieties are Frankish Brewing and several selections of Chevalier, which averaged yields of 37 to 41 bushels.

North Dakota.

Table VI gives the average yield of the varieties of barley grown at the North Dakota station from 1902 to 1907, with the average number of days each required to mature. The 1905 crop is not included in the averages.

TABLE VI.—*Average yields of 10 varieties of barley and the average time each required to mature at the North Dakota station, for five years, 1902, 1903, 1904, 1906, and 1907.*

Name of variety.	Group.	Yield per acre.	Time to mature.	Name of variety.	Group.	Yield per acre.	Time to mature.
		Bushels.	*Days.*			*Bushels.*	*Days.*
Russian	Six-row	42.7	84	Great Beardless	Six-row	32.3	81
Common	...do	42.5	83	Moravian	Two-row	40.4	85
Silver King	...do	40.0	84	Highland Chief	...do	37.3	95
Manchuria	...do	40.3	82	Mansury	...do	37.0	94
Barnards	...do	38.3	84	McEwans	Hull-less	34.5	83

From these trials it appears that there is little difference in the yields of the six-rowed and two-rowed barleys in eastern North Dakota. In 1908, however, a number of pedigreed two-rowed barleys were sown, which considerably outyielded the best six-rowed varieties. The yields were: Hannchen, 67 bushels; Chevalier, 66 bushels; Primus, 64.6 bushels; Hanna, 56 bushels; Princess, 47.3 bushels; with an average of 60 bushels for the five pedigreed varieties. Russian, the leading six-rowed barley in the table, yielded 52.7 bushels to the acre in 1908, or 7.3 bushels less than the average for the pedigreed two-rowed varieties.

Barley has been grown at the Edgeley, N. Dak., substation since 1904. In a 6-year trial, from 1904 to 1909, a two-rowed variety gave an average yield of 37.42 bushels to the acre, 3.83 bushels greater than the best six-rowed variety. In the three years from 1907 to 1909, however, there was little difference in yield between the two-rowed and six-rowed barleys. The Blue Ribbon, New Moravian, Manchuria (Minn. No. 105), and White Hull-less varieties were grown during this period. In the 3-year average Blue Ribbon led, with a yield of 28.4 bushels. A large number of varieties were tested in 1908 and 1909; the best of them are grouped in Table VII, according to type and rank in yield. The average number of days each required to mature is also given. In this 2-year test the two-rowed varieties yielded slightly better than the six-rowed. The highest yielding two-rowed variety was Black Smyrna, with an average yield of 40.9 bushels to the acre.

TABLE VII.—*Annual and average yields of 18 varieties of barley and the average time each required to mature at the Edgeley, N. Dak., substation, 1908 and 1909.*

Name of variety.	Group.	Yield per acre (bushels). 1908.	1909.	Average.	Days to mature.
Black Smyrna	Two-row	40.80	41.00	40.90	92
Smyrna	do	38.70	41.00	39.85	92
Hannchen	do	32.40	33.60	33.00	97
Hanna	do	30.30	41.40	35.85	95
Bohemian	do	30.30	31.90	31.10	95
Bavarian	do	30.30	30.10	30.20	97
Swan Neck	do	28.20	30.50	29.35	97
Odessa	Six-row	44.30	33.60	38.95	99
Gatami	do	31.70	42.80	37.25	95
Mariout	do	30.30	43.20	36.75	92
Golden Queen	do	35.90	30.00	32.95	95
Manchuria	do	31.60	33.90	32.75	96
Summit	do	28.20	35.20	31.70	97
Oderbrucker	do	25.40	32.50	28.95	93
Boehme's Hull-less	Hull-less	26.50	30.70	28.60	94
Black Hull-less	do	21.40	31.70	26.55	93
White Hull-less	do	20.80	31.00	25.90	94
Do	do	20.30	29.80	25.05	94

At the Dickinson substation the two-rowed barleys far outyielded the six-rowed type in 1908 and 1909. The leading varieties in this trial were the Hannchen, the Swan Neck, and the Chevalier II, with average yields of 43.15, 42.13, and 40.97 bushels to the acre, respectively. The highest yielding variety of the six-rowed type was the Gatami, with an average yield for the two years of 29.66 bushels.

The average for Hanna for the three years 1907–1909 is 40.10 bushels to the acre; Imperial, 34.36 bushels; Gatami, 31.99 bushels; Manchuria, 24.87 bushels. The yields of 7 two-rowed and 4 six-rowed varieties for the years 1908 and 1909 are shown in Table VIII.

TABLE VIII.—*Annual and average yields of 11 varieties of barley, showing average weights per bushel and the average time required to mature at the Dickinson, N. Dak., substation, 1908 and 1909.*

Name of variety.	Group.	Yield per acre (bushels).			Pounds per bushel.	Days to mature.
		1908.	1909.	Average.		
Hannchen	Two-row	37.50	[a] 48.80	43.15	52.25	104
Swan Neck	do	39.37	44.90	42.13	49.00	103
Chevalier II	do	36.15	45.80	40.97	51.50	107
Hanna	do	28.54	39.89	34.21	50.50	108
Princess	do	32.71	38.50	35.60	50.00	109
Imperial	do	28.33	40.40	34.36	51.50	109
Primus	do	29.27	36.70	32.98	51.75	106
Gatami	Six-row	31.42	27.90	29.66	48.75	103
Oderbrucker	do	22.08	30.00	26.04	48.25	100
Manchuria	do	27.92	30.20	29.06	48.75	103
Hull-less	do	17.66	19.20	18.43	62.25	105

[a] Average of three check plats.

At the Williston substation a number of varieties of barley have been grown for the three years 1908–1910, on land which had not previously been cropped. The results of these trials are shown in Table IX. The yields in 1908 and 1910 were low, owing to lack of moisture, while the high yields of 1909 were caused by favorable weather conditions, as the soil and its preparation were similar in all three years.

TABLE IX.—*The annual and average yields of 13 varieties of barley at Williston, N. Dak., substation, for 1908, 1909, and 1910.*

Name of variety.	Group.	Yield per acre (bushels).			
		1908.	1909.	1910.	Average.
Manchuria (Minnesota No. 6)	Six-row	15.7	57.0	8.1	26.9
Common	do	18.2	53.7	6.1	26.0
Bernard's	do	17.1	52.1	5.7	25.0
Silver King	do	12.0	57.2	4.7	24.6
Russian	do	11.3	57.8	3.9	24.3
Manchuria (Minnesota No. 105)	do	14.3	49.4	6.7	23.4
Manchuria	do	13.3	53.5	4.5	23.7
Minnesota No. 32	do	13.7	50.3	3.8	22.6
Minnesota No. 87	do	9.8	51.3	2.6	21.2
Moravian	Two-row	10.0	56.0	3.9	23.3
Mansury	do	6.4	56.0	2.0	21.5
Highland Chief	do	10.6	47.8	2.4	20.3
Success	do	11.3	46.0	1.2	19.5

Table IX shows that of the varieties tested the six-rowed were superior to the two-rowed. The highest yielding variety in the 3-year test was Manchuria, a six-rowed variety, with an average yield of 26.9 bushels to the acre for the three years. Common and Bernard's, both six-rowed varieties, ranked second and third in this test. The average yield of the 7 six-rowed varieties for the three years was 24.2 bushels, and of the 4 two-rowed 21.1 bushels.

South Dakota.

Table X gives the average yields of the best varieties of barley grown at the South Dakota station at Brookings during the five years 1905 to 1909, inclusive. The range in number of days from planting to maturity during the period is also given. The hull-less barleys matured from two to six days earlier than the other varieties and the six-rowed from four to six days earlier than the two-rowed kinds.

TABLE X.—*Average yield of 11 varieties of barley, and the time required to mature, at the South Dakota station for five years, 1905–1909.*

G. I. No.	Name of variety.	Group.	Average yield per acre.	Time to mature.
			Bushels.	*Days.*
187	Swan Neck	Two-row	43.50	96–102
	Chevalier	...do	41.21	96–105
24	Hanna	...do	40.66	94–105
	Hannchen	...do	39.55	94–103
182	Odessa	Six-row	43.91	90–101
	Manchuria (Minnesota No. 6)	...do	40.54	90–101
170	Manchuria	...do	38.28	90–101
184	Common	...do	38.22	90– 99
336	Grecian	...do	36.98	90–102
22	Hull-less	...do	26.07	88–101
335	Little Blue Hull-less	...do	22.19	94–104

In the trials at this station there has been little difference in the yields of the two-rowed and the six-rowed groups. The highest average yield for the five years, 43.91 bushels to the acre, was obtained from a six-rowed variety, the Odessa, while the Swan Neck, a two-rowed variety, ranked second with 43.50 bushels. Other leading two-rowed varieties were Chevalier and Hanna, while Manchuria (Minnesota No. 6) ranked next to Odessa among the six-rowed kinds.

Table XI gives the 5-year and 7-year average yields of the best varieties of barley at the Highmore substation, arranged according to type and rank in yield.

TABLE XI.—*Average yield of 10 varieties of barley at the Highmore, S. Dak., substation for periods of five to seven years.*

G. I. No.	Name of variety.	Group.	Average yield per acre for period (bushels).	
			Five years (1905–1909).	Seven years (1903–1909).
531	Hannchen	Two-row	33.9	....
27	Bohemian	...do	33.0	27.7
530	Chevalier	...do	32.4	....
24	Hanna	...do	32.1	28.2
203	....do	...do	32.1	27.1
34	....do	...do	31.9	26.6
32	Bohemian	...do	31.2	26.4
31	Horn	...do	29.0	24.6
532	Primus	...do	27.1	....
....	Manchuria (Minnesota No. 6)	Six-row	28.3	26.5

In the 7-year period the Manchuria (Minnesota No. 6) six-rowed has yielded nearly as well as the two-rowed barleys. In the 5-year average, however, the two-rowed barleys considerably outyielded the

six-rowed. The Odessa and the Manchuria (Minnesota No. 105), both six-rowed varieties, which have been grown only four years, have yielded less than the Manchuria (Minnesota No. 6). From the results obtained during the seven years' trial it is evident that the two-rowed varieties are better adapted to the central section of the State than the six-rowed. In 1909 the length of the ripening period ranged from 75 to 86 days, the Odessa (six-rowed) and the White Smyrna (two-rowed) being the earliest and the Princess the latest in ripening. The weight per bushel varied from 41 pounds for the Primus and Princess to 48 for White Smyrna. Only two varieties attained the legal weight, 48 pounds, in 1909.

The results obtained in the variety trials of barley at the Bellefourche Experiment Farm in 1908 and 1909 are given in Table XII.

TABLE XII.—*Annual and average yields and weight per bushel of 9 varieties of barley at the Bellefourche Experiment Farm, 1908 and 1909.*

G. I. No.	Name of variety.	Group.	Yield per acre (bushels). 1908.	1909.	Average.	Pounds per bushel.
643	Manchuria	Six-row	26.0	17.3	21.7	47.3
....	Manchuria (Minnesota No. 6)	...do	....	19.8	....	45.5
182	Odessa	...do	....	22.1	....	51.5
24	Hanna	Two-row	29.0	23.8	26.4	51.5
203	.....do	...do	27.9	21.4	24.7	51.5
530	Chevalier	...do	....	22.1	....	51.0
531	Hannchen	...do	....	19.2	....	51.0
262	Hull-less	Hull-less	16.3	9.6	13.0	61.0
....	White Hull-less	...do	12.0	9.0	10.5	60.0

The highest average yield, 23.8 bushels, was obtained from a two-rowed variety, the Hanna. While trials for one or two years are insufficient to judge the relative value, the indications are that the two-rowed barleys are the most profitable in western South Dakota.

Kansas.

At the Kansas (Manhattan) station Tennessee Winter barley leads in yield, the average for six years being 48.80 bushels to the acre. Manchuria, the best six-rowed spring barley, gave an average yield of 33.53 bushels, which is 15.3 bushels less than that of Tennessee Winter for the same period. Table XIII shows the annual and average yields of 7 varieties grown at this station from 1904 to 1909.

TABLE XIII.—*Annual and average yields of 7 varieties of barley at the Kansas Station, 1904–1909.*[a]

Name of variety.	Yield per acre (bushels). 1904.	1905.	1906.	1907.	1908.	1909.	Average.
Manchuria	25.75	38.74	12.71	30.31	45.77	47.91	33.53
Manchuria (Mansury)	30.46	42.32	12.93	32.94	44.06	36.22	33.15
Common	26.92	46.55	16.39	14.83	42.89	26.71	29.05
Success Beardless	28.27	35.22	14.16	20.57	36.23	39.69	28.52
Black	19.89	32.75	14.40	21.08	37.03	31.50	26.11
Bonanza	27.43	42.89	12.56	29.23	44.96	35.53	32.10
Tennessee Winter	34.18	81.19	66.90	12.20	32.69	65.65	48.80

[a] From a special report made by Prof. A. M. Ten Eyck in 1909.

At the McPherson substation the 4-year average from 1906 to 1909 shows that the six-rowed spring barleys yielded best. Caucasian

ranked first with an average of 30.3 bushels; Odessa and Yenidje followed with 28.9 and 28.5 bushels, respectively. The best yielding two-rowed barley was Black Smyrna, with a yield of 23.9 bushels. The winter barleys have not given as good results at this station as at Manhattan. They ranked lower than the two-rowed barleys.

TRIALS IN THE ROCKY MOUNTAIN AND PACIFIC STATES.

Montana.

Table XIV gives the average returns from the different groups of barley in a 2-year test at the Montana station.

TABLE XIV.—*Average yields of both grain and straw and average weight per bushel of the different groups of barley in a 2-year test at the Montana station.*

Group.	Number of varieties.	Average yield per acre.			Days to mature.	Pounds per bushel.
		Grain.[a]		Tons of straw.		
		Bushels.	Pounds.			
Hull-less	13	56.8	3,408	1.69	119	59.7
Two-row	13	66.0	3,168	2.00	119	50.5
Six-row	4	52.0	2,496	1.64	117	48.3

[a] The legal weight of hull-less barley is 60 pounds to the bushel, while that of the hulled type is 48 pounds. For this reason, the average yield in pounds of the hull-less varieties in this test was greater than that of the two-rowed hulled varieties, though the hull-less produced the smaller number of bushels.

The following conclusions were drawn from the results presented in the foregoing table:

(1) The largest feed returns are obtained from the hull-less barleys.
(2) The two-rowed varieties gave much larger yields than the six-rowed.
(3) An average of the varieties tested shows a yield of 1.26 pounds of straw for each pound of grain in the two-rowed and 1.31 pounds of straw for each pound of grain in the six-rowed. In the hull-less barleys there was 1 pound of straw to each pound of grain.

The results of only two years, 1909 and 1910, are available from the recently established Judith Basin substation at Philbrook, Mont. Table XV shows the yields obtained and the number of days required to mature. All except the hull-less varieties were sown at the rate of 4 pecks per acre; of these, only 3 pecks were sown.

TABLE XV.—*Average yields of 8 varieties of barley and the average time each required to mature in 1909 and 1910, also the weight per bushel of each in 1910, at the Judith Basin substation.*

Name of variety.	Group.	Yield per acre (bushels).			Pounds per bushel, 1910.	Days to mature.
		1909	1910	Average.		
Hanna	Two-row	53.30	11.00	32.15	44	94.5
Bohemian	do	48.50	11.20	29.85	46	101.0
Mansury	do	45.70	13.00	29.35		94.5
Manchuria (Minnesota No. 105)	Six-row	45.20	9.80	27.50	44	99.5
White hull-less	Six-row hull-less	42.40	16.40	29.40	59	93.5
Black hull-less	do	43.80	13.60	28.70	58	95.0
Himalaya (Guy Mayle)	do	33.20	12.10	22.65	58	101.5
McEwan's hull-less	Two-row hull-less	32.60	10.00	21.30	58	95.0

The highest yield to the acre, 32.15 bushels, was obtained from a two-rowed variety, the Hanna; but the White Hull-less and the Black

Hull-less yielded only about 3 bushels less, and, owing to their greater weight per bushel, actually produced a greater number of pounds of grain than the Hanna.

Wyoming.

At the Laramie station the two-rowed barleys led in yield. In 1907 the 7 best two-rowed barleys averaged 35.6 bushels to the acre, and the 7 best six-rowed, 32.5 bushels. In 1909 the 3 best two-rowed varieties, Smyrna, Swan Neck, and Primus, averaged 43.3 bushels of 53 pounds in weight, while the best six-rowed, Gatami, Frankish, and Common Six-rowed, averaged 43.9 bushels of 49 pounds each. Two six-rowed hooded hull-less barleys averaged 31 bushels of 64 pounds each.

Colorado.

At the Akron substation in eastern Colorado the results of two years' experiments (1908 and 1909) in field plats show little difference in yield between the two-rowed and six-rowed barleys. California Feed, a six-rowed variety, led in yield, averaging 35.6 bushels, while Hannchen, the best two-rowed, averaged 34.8 bushels.

Utah.

At the Nephi, Utah, substation the six-rowed barleys have been most successful. The average yield of the California Prolific barley for the 7 years, 1904 to 1910, was 19.86 bushels, and of the Common California 19.69 bushels. The average yield of barley for two years, 1909 and 1910, was 17.85 bushels for Utah Winter and 17.30 bushels for Tennessee Winter. In these two years the spring barleys, California Prolific and Common California, averaged only about 7 bushels to the acre.

California.

Table XVI gives the average yields of barley grown on the experiment farm at Modesto, Cal., 1906 to 1909.

TABLE XVI.—*Average yields of 5 varieties of barley at Modesto, Cal., for periods varying from two to four years.*

Name of variety.	Group.	Years grown.	Yield per acre.
			Bushels.
Beldi	Six-row	2	22.75
Common	...do	3	26.70
Mariout	...do	3	15.15
Tennessee Winter	...do	2	25.65
White Smyrna	Two-row	4	24.54

The highest yields were obtained from Common California and Tennessee Winter, six-rowed varieties, and from White Smyrna, which is two-rowed. The yields were considerably reduced by the depredations of squirrels and by other detrimental factors. In 1908 White Smyrna yielded 65.02 bushels and Common, 55 bushels; in 1909 Tennessee Winter yielded 67.6 bushels. The average yield for the State is 26.5 bushels.

YIELD OF BARLEY COMPARED WITH THAT OF OTHER CEREALS.

Oats generally give a larger yield than barley in bushels per acre, but if the weight of grain produced is compared it will be found that barley generally gives the best returns. Table XVII shows that in the United States barley produces more pounds of grain to the acre than any of the other important cereals except corn.

TABLE XVII.—*Average yields of corn, barley, oats, wheat, and rye in the United States for each of four 10-year periods, 1866 to 1905.*

Period.	Average yield per acre (pounds).				
	Corn.	Barley.	Oats.	Wheat.	Rye.
1866–1875	1,461	1,099	899	714	594
1876–1885	1,438	1,075	833	738	473
1886–1895	1,310	1,084	819	762	390
1896–1905	1,411	1,204	947	810	452
Average	1,405	1,115	874	756	477

For the 10-year period from 1900 to 1909 barley gave an average yield of 25.7 bushels, or 1,234 pounds, of grain to the acre. The average yield of wheat was 10.8 bushels, or 648 pounds, per acre; of oats, 29.5 bushels, or 944 pounds; and of rye, 10.3 bushels, or 577 pounds. These figures show that barley produced nearly twice as much grain as wheat, 1.3 times as much as oats, and more than 2.1 times as much as rye. The average yield of corn of the 10-year period was 25.7 bushels, the same as barley; the weight of grain produced, however, was 1,439, or 205 pounds per acre more than barley.

The average yields in pounds per acre of the different grains for eight years at the North Dakota station were as follows: Oats, 1,969 pounds; emmer, 1,949 pounds; barley, 1,877 pounds; durum wheat, 1,835 pounds; common wheat, 1,711 pounds.

At Dickinson, N. Dak., in a 3-year test, from 1907 to 1909, of the comparative quantity of grain produced per acre by the different cereals, it was found that oats ranked highest, producing 2,311 pounds; barley came next, with 2,011 pounds; emmer third, with 1,893 pounds; and wheat fourth, with 1,871 pounds.

Interesting statistics covering a period of 26 years have been collected in Ontario, giving the average yields in bushels and pounds per acre of the grain crops grown in that Province. These figures are as follows:

Barley, 27.7 bushels; or 1,330 pounds per acre.
Winter wheat, 20.6 bushels; or 1,236 pounds per acre.
Oats, 35.8 bushels; or 1,217 pounds per acre.
Spring wheat, 15.9 bushels; or 954 pounds per acre.
Rye, 16.3 bushels; or 913 pounds per acre.

The standard weight per bushel of oats in Canada is 34 pounds, and of barley 48 pounds, consequently a bushel of barley weighs nearly as much as 1½ bushels of oats. While oats averaged 8.1 bushels more per acre than barley, on account of the greater weight per bushel the barley produced 113 pounds more grain. Barley produced a greater weight of grain per acre than any other cereal.

SOWING BARLEY AND OATS TOGETHER FOR GRAIN.

A common practice in some sections in Canada and of the United States is to sow barley and oats together for the production of grain, as increased yields are usually obtained. This mixed grain is, of course, not readily marketable, but is used for feeding on the farm where it is produced. Where barley and oats are sown together it is necessary to select varieties that mature about the same time.

As a result of two years' experiments in testing 19 different grain mixtures at the Ontario Agricultural College, the largest yield per acre of grain, 3,021 pounds, was produced from a mixture of 48 pounds of Manchuria barley and 34 pounds of Alaska oats. The next highest yield, 2,985 pounds, was from a mixture of 48 pounds of Manchuria barley and 34 pounds of Daubeney oats. Nearly always more than half of the crop produced was barley. In a mixture of 1 bushel each by measure of Manchuria barley and Banner oats sown together it was found that the crop was about two-thirds barley and one-third oats in weight. A mixture of 48 pounds of Manchuria barley and 60 pounds of Himalaya (Guy Mayle, hull-less) barley gave a yield of 2,986 pounds.

The same institution has conducted experiments for a number of years with various mixtures of oats and barley in order to find the rate of seeding which would give the best results. The lightest seeding was one-half bushel of each and the heaviest 1½ bushels of each by weight. The trial was continued for six years, 1899 to 1904, the average results showing that the greatest number of pounds of grain per acre was produced from a mixture of 1 bushel of oats (34 pounds) and 1 bushel of barley (48 pounds), or 82 pounds of the mixture to the acre. In 1907 a test was conducted along the same line, using Manchuria six-rowed barley with Daubeney oats and Chevalier two-rowed barley with Siberian oats. In 1908 Canadian two-rowed barley was used instead of Chevalier. Nine different combinations of oats and barley were used, varying from 3 to 5 pecks of each grain. The highest average yield of grain for the two years, 2,566 pounds, was produced from the seeding of 4 pecks each of oats and barley, a close second being 2,537 pounds from 3 pecks of oats and 5 pecks of barley. Four pecks of oats and 5 pecks of barley produced 2,529 pounds of mixed grain. The largest average quantity of straw, 1.70 tons, for the two years was from the 4 pecks of oats and 3 pecks of barley, the smallest being 1.55 tons from 5 pecks of oats and 4 pecks of barley.

DISEASES AFFECTING BARLEY.

Barley is subject to a number of diseases, of which the most injurious are the rusts and smuts. Brief descriptions of these diseases, with methods of treatment, follow.

Loose smut of barley (*Ustilago nuda*) is a fungous parasite that infects the plant at the flowering time of the grain. The following year the plants grown from seeds matured from infected flowers produce smutted heads. Within a short time after the maturity of the spores they are scattered by the wind and only the bare stem remains. Figure 17, *B*, shows heads of barley affected with loose

smut. The disease is widely prevalent, in some localities the loss incurred being from 2 to 10 per cent of the crop. The disease can be controlled by treating the seed with the modified hot-water treatment in connection with a seed plat.[a]

Covered smut of barley (*Ustilago hordei*) infects the plant in a different manner. The spore does not enter the seed, but simply adheres to it and is sown with it, infecting the young plant just after the germination of the seed. While the barley is maturing each grain is replaced by a mass of dark spores. The spores are then scattered over the grain in harvesting and thrashing. Machinery, sacks, and bins which contain smut spores are frequent sources of infection. Figure 17, *A*, shows heads of barley in which the grains are replaced by masses of spores of this smut. Treating the seed for 30 minutes with a solution of 1 pound of formalin[b] to 40 gallons of water will aid in preventing it.

FIG. 17.—The covered and loose smuts of barley: *A*, Covered smut, in which the kernel is replaced by masses of spores; in the left-hand head the awns are reduced in size; in the center head the spikelets are distorted and the awns nearly destroyed; the right-hand figure is that of a head of hooded barley, showing the large spore masses. These are broken apart and mixed with the grain in thrashing. *B*, Loose smut. In this form the entire spikelet is replaced by a mass of spores, which upon maturity are scattered by the wind, leaving only the bare stems as evidence of the disease.

Barley is subject to both leaf rust (*Puccinia simplex*) and stem rust (*Puccinia graminis hordei*). The first stage of these diseases is called the "red-rust stage" and may be recognized by the reddish-brown

[a] A detailed description of the hot-water method of treatment for loose smut of barley is given in Bulletin 152, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1909.

[b] A more complete description of the formalin and other treatments for covered smut of barley is given in Farmers' Bulletin 250.

spots on the stems and leaves. The spores formed in these spots are scattered by the wind and cause infection the same season. Cool, dewy nights and muggy days are especially favorable to the development of the rust. Later in the season black elongated spots can be seen on the stems and bases of the leaves. These contain the spores which will live over winter. No absolute remedy is known. Burning the straw and stubble of badly infected fields has been recommended as a preventive against rust the following season. As squirrel-tail grass, quack-grass, and slender wheat-grass are subject to rust, they should not be allowed to grow in or near grain fields. The selection of early-maturing and rust-resistant varieties of barley and the use of well-drained land are recommended.

Ergot (*Claviceps purpurea*) is not common on barley, but is occasionally found in the Great Plains States. It is due to a parasite which attacks the immature grains and replaces them by large black or purplish-black masses. These fall off and remain in the field over winter, or are sown with the grain, and from them come the spore-producing bodies in which are formed the spores which attack the crop. No absolute preventive is known. It is desirable to separate the black masses from the grain by screening before planting.

Yellow-leaf disease of barley (*Helminthosporium graminum*), while not common in all parts of the United States, has caused considerable damage in certain portions. Dr. L. H. Pammel described it as one of the most destructive of the parasitic diseases affecting barley in Iowa. Attacks have also been noted in the Southern and Central States. The disease may be identified by the yellowing and splitting of the leaves of the young plant. Frequently the entire plant is affected and may be killed by the fungus. A close inspection of the diseased leaves will show small black spots which contain the spores. No remedy is known.

Powdery mildew (*Erysiphe graminis*) sometimes occurs on this crop, but it is generally not severe enough to cause much damage. It is easily recognized by the small, cottony masses (mycelium) on the leaves. This disease receives its nourishment by sending its sucker-like organs, known as "haustoria," into the outer cells of the leaf, causing them to turn brown. It is spread by means of spores, which generally attack the basal leaves of the plant first and are most injurious in thickly sown grain on damp ground. Well-drained fields suffer least.

INSECTS INJURIOUS TO BARLEY.

Insects affecting the growing crop.—Barley, like other grain crops, is attacked by a number of injurious insects. Among those which attack the growing crop is the spring grain-aphis,[a] or "green bug" (*Toxoptera graminum*). During the season of 1907 many acres of barley in Kansas, Oklahoma, and Texas were ruined by it.

The Hessian fly[b] (*Mayetiola destructor*) is so well known that no description is necessary. While by preference it attacks wheat, it will

[a] A full description of the spring grain-aphis, with suggestions for its control, is given in Circular 93, Bureau of Entomology, U. S. Dept. of Agriculture.

[b] Methods of prevention and treatment for the Hessian fly are given in Circular 70, Bureau of Entomology, U. S. Dept. of Agriculture.

also breed in barley, especially in localities where the barley is planted earlier than the wheat.

In some localities the chinch bug[a] (*Blissus leucopterus*) infests barley and causes considerable damage.

Insects attacking the stored grain.—Among the injurious insects which attack stored grain are the Angoumois grain moth and the various grain beetles and weevils. The presence of the Angoumois grain moth can be noted as the adults fly around the seed room or bin when the grain is disturbed. The moth resembles the common clothes moth. The larva burrows into and consumes the interior of the grain, leaving only the outer portion. A poor stand of grain is very often due to the fact that the germs were destroyed by the larvæ of this insect. The grain weevils and the small, elongated, reddish-brown or blackish beetles, which differ from the weevils in not having the elongated snout, also damage stored grain, especially in the South. Fumigation with carbon bisulphid or hydrocyanic-acid gas is effective in keeping all these insects in check; but fumigation should not be undertaken without a thorough knowledge of the methods of using these chemicals, for both are dangerous to handle.[b]

Seed grain can be protected from both insects and vermin by storing it in galvanized-iron bins with tight lids, or in tight wooden bins inclosed with small-mesh wire netting. Before the grain is placed in the bin it should be fumigated with carbon bisulphid. The fumes should not be inhaled, and, as they are highly inflammable, no light should be brought near while the chemical is being used.

IMPROVEMENT OF THE CROP.

STATEMENT OF METHODS.

The mean yield of barley in the United States for ten years, 1900 to 1909, was 25.7 bushels to the acre. The lowest annual average yield for that period was 20.4 bushels, in 1900; and the highest, 29 bushels, in 1902. Many methods of improving the yield and quality of the crop are practiced, but the most important are (1) the introduction of improved seed from other countries, (2) the improvement of the varieties now grown, (3) the production of new strains by hybridization, (4) the proper selection and preparation of the soil, and (5) the use of the best methods in harvesting.

THE INTRODUCTION AND DISTRIBUTION OF PURE SEED.

Practically all the pure races of barley now grown in the United States have been produced by the experiment stations or introduced by the Department of Agriculture. These pure strains have proved their superiority wherever the conditions have been favorable. The Offices of Seed and Plant Introduction and of Grain Investigations of this Department are giving much attention to the improvement of barley, the former through the introduction of new varieties, the

[a] The chinch bug is discussed in Circular 113, Bureau of Entomology, U. S. Dept. of Agriculture.

[b] Full directions for fumigation with hydrocyanic-acid gas are given in Circular 112, Bureau of Entomology, U. S. Dept. of Agriculture, and for fumigation with carbon bisulphid in Farmers' Bulletin 145.

latter by testing a large number of varieties, the selection of those best adapted to the different areas, and the production of pure strains.

The most promising of the introduced varieties are the Chevalier, Hannchen, Hanna, Primus, Swan Neck, Princess, Odessa, and Gatami. Several excellent strains of winter barley have been developed. The variety known as Tennessee Winter, which was selected at the Tennessee station, has been widely distributed by the Department of Agriculture over the Southern and South-Central States with excellent results. In many localities it has entirely replaced the spring barleys. Several forms of winter barley without awns have been produced by the Office of Grain Investigations, which will no doubt prove of considerable value when fully developed.

THE IMPROVEMENT OF EXISTING VARIETIES.

Means of selection.—The varieties of barley which are now commonly in cultivation in the United States can be improved (1) by the mechanical selection of the seed and (2) by the field selection of the best plants or heads.

Mechanical selection.—The seed is a vital factor in the production of good barley, for it contains the germ and the food material to start either a strong and vigorous plant or a weak and puny one. If the seed is small and shriveled maximum yields can not be expected. It is for this reason that the farmer is urgently advised to fan and clean his seed in order to remove the weak and save only the plump grain. Experiments have shown that these imperfectly formed seeds seldom produce plants with large, well-developed heads, and that these plants stool less than those produced from large, plump seeds. By thoroughly fanning and screening the seed and further cleaning it by the skimming process later described, the imperfect barley grains, oat and weed seeds can be removed and only the plump barley saved. By planting only the plump grain the stand and yield will be greatly improved.

An excellent method by which light and diseased grains of barley and impurities such as oats and weed seeds can be removed, and by which the grain can be treated for smut at the same time, is as follows:[a] Make a formalin solution at the rate of 1 pound of formalin to 40 gallons of water; partly fill a tub with this solution and pour into it the seed to be treated. Stir the seed thoroughly and skim off the oats, weed seeds, and chaffy grains which rise to the surface. The solution should then be drained off and the seed dried in a clean place.

Field selection.—The barley crop can be further improved by the selection of the best plants in the field. In all fields of grain individual plants can be found that are superior to the rest, either in height or form of plant, or size of head or grain. These better individuals should be selected and planted separately the following season, thus establishing pure types of the variety. The best selections should then be increased until they can be put into field tests.

Results may be obtained more quickly by selecting a large number of the best heads of the same type and planting them together, though the chances of mixture are considerably greater and the variety will

[a]A complete description of this method of cleaning seed barley is given in Circular 62, Bureau of Plant Industry, U. S. Dept. of Agriculture.

not be as pure as when only one head is used. By sowing the grain produced by the selected heads the following year in a separate plat, for convenience called the "breeding plat," the grower can readily see whether they come true to type. If the weak and undesirable plants and those that do not come true to type are removed, the yield and quality of the variety can be considerably improved within a few years.

At the Kansas station Mansury, Bonanza, and Manchuria barleys have been selected for 3 years, 1907 to 1909, and the average yields increased from 0.62 bushel to 4.75 bushels during that time. At the Wisconsin, Minnesota, Tennessee, and many other stations excellent results have been obtained and the varieties much improved by careful selection of the seed.

SUMMARY.

Barley is supposed to be a native of western Asia, where wild forms still exist. It was one of the first cereals cultivated for food. Barley belongs to the grass family or Gramineæ, and to the genus Hordeum.

There are two groups of barley, the two-rowed and the six-rowed. Further subdivisions are made into bearded and hooded (beardless) types, including both the common and the hull-less varieties in each type.

This crop was introduced into America by the early colonists. Improved varieties were first distributed in the United States about 1845. Among the most important introductions were the hooded types, including hull-less forms. In recent years a number of valuable varieties have been introduced by the Department of Agriculture from Europe.

The greater portion of the crop is produced in the States of Minnesota, California, Wisconsin, North Dakota, and South Dakota.

The six-rowed barley is most widely grown in the United States. The best yielding varieties are Manchuria, Oderbrucker, Odessa, Gatami, and California. Among the best of the two-rowed varieties may be mentioned Chevalier, Hannchen, Swan Neck, Kitzing, and Hanna. The hooded (beardless) and hull-less barleys yield well in the semiarid and Rocky Mountain States. In the Southern and Central States the winter varieties are the most profitable ones to grow.

Barley requires a well-drained, porous soil for its best development. Loamy soils give the best yields.

Barnyard and green manures should be plowed under for some time previous to planting this crop. If fertilizers are used, they should be rich in phosphates.

Barley should follow corn, potatoes, or other cultivated crops in the rotation. It is an excellent nurse crop for legumes and grasses.

In preparing the soil for barley it should be well worked and free from weeds.

All light seed and impurities should be removed by fanning and screening or by the skimming process.

In the Northern States barley is sown from April 1 to May 15, while in the Central States seeding is generally done from March 15 to April 15. In the Pacific States this crop is sown either in the winter or spring. Winter barley in the Southern States is usually

sown from September 15 to October 15. The usual rate of seeding in humid regions is 2 bushels; where the rainfall is slight, best results are obtained from the use of 4 to 6 pecks. Drilling gives better results than broadcast seeding.

In the semiarid regions harrowing after the plants come up is often beneficial. Considerable barley is grown under irrigation in the Intermountain States.

To obtain the best quality of grain, barley should be cut when in the hard-dough stage. Some growers prefer to cut when fully ripe. The grain should be shocked in oblong rather than in round shocks, as the oblong shocks allow it to cure better. Where there are no high winds, the shocks should be capped. The grain is of much better color and quality if the crop is stacked instead of being allowed to stand in the shock till thrashing time. In thrashing barley the concaves should not be set too close, or there will be considerable broken grain. The grain should be carefully housed after thrashing to prevent injury from moisture and insects.

Barley is subject to both loose and covered smut. Loose smut can be controlled by the modified hot-water treatment, while treating the seed with formalin will destroy the covered smut.

The growing grain is sometimes injured by the "green bug," chinch bug, and Hessian fly. Rotation of crops, and, for the Hessian fly, rotation with reasonably late seeding, are the most efficient remedies. Insects which attack barley in the bin can be kept in check by fumigating with hydrocyanic-acid gas or carbon bisulphid.

Numerous tests of varieties of barley have been made at the various State agricultural experiment stations. Oderbrucker, a six-rowed variety, produced the highest yield at the Wisconsin station. At the Minnesota station Manchuria and Russian were the best six-rowed varieties; Hannchen, Chevalier, and Primus are the best two-rowed. At the North Dakota station Russian was the best six-rowed barley and Moravian the best two-rowed. At the Edgeley and Dickinson substations the two-rowed varieties led in yield, while at Williston the six-rowed were best. The best six-rowed barley yielded slightly more than the best two-rowed at the South Dakota station. At the Highmore substation and the Bellefourche Experiment Farm the two-rowed varieties yielded best. At Manhattan, Kans., Tennessee Winter barley led in yield and Manchuria was the best spring variety. At McPherson, Kans., the six-rowed spring varieties yielded best. At the Montana station the largest feed returns were obtained from the hull-less varieties. The two-rowed barleys were superior to the six-rowed at the Wyoming station. At Akron, Colo., and Modesto, Cal., these two groups differed little in yield. At Nephi, Utah, the six-rowed barleys are the most profitable.

In order to prevent its running out or deteriorating, the seed grain should be thoroughly cleaned and graded before planting. This will insure strong, healthy plants and a good quality of grain. Where no fanning mill is available, the skimming process gives excellent results.

A small breeding plat, in which is planted the seed from selected heads gathered from the standing grain, will enable the farmer to improve the yield and quality of his crop.

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